A Year's Work of the London Board of Works.

The annual report of the Finance Committee was presented to the Metropolitan Board of Works at the meeting on the 8th inst. It states that the Board has been engaged since the year 1879, in constructing in various parts of the metropolis additional large sewers by way of supplementing and relieving some of the sewers of the main drainage system which, in times of heavy rain, were found inadequate to carry off with sufficient rapidity the enormous volumes of water which found their way into them. During the year just ended the following new sewers had been completed or were in progress: Deptford overflow sewer, completed in September last, at a cost of 33,000*l*; new sewers from Putney to Clapham, at a cost of 151,995*l*. 19*s*., more than half of this completed; the Eltham drainage, at a cost of 23,500*l*.; Ranelagh and King's Scholars' Pond sewers, at a cost of 96,300*l*.; Bridge Road, Hammersmith, and Stamford Brook sewers, at a cost of 8,353*l*. Various works have been done during the year to keep the buildings and machinery of the pumping stations in good order, and also other works under the Board's general contracts. Since the year 1871 the cleansing of the main and intercepting sewers (in all, about 250 miles in length) has been done by a special staff of men employed by the Board for the purpose. The cost of the work during the past year was about 14,000*l*. The allied subject of the state of the Thames and the investigation by Lord Bramwell's commission are next considered. As the summer of 1884 was unusually hot and dry, the Board found it necessary, during a portion of the year, to take measures for deodorizing the sewage at the outfalls. The Board had set up apparatus and machinery at the Crossness pumping station, which would enable it to manufacture in sufficient quantities the compounds required for deodorizing.

During the past year the Board had been engaged in acquiring the property which had to be taken for the formation of the new street from Tottenham Court Road to Charing Cross, and claims have been settled to the amount of 278,076*l*. Claims in respect of property required for the new street from Oxford Street to Piccadilly Circus, to the amount of 45,572*l*., have been settled, and nearly all the property required has now been acquired. Of the widening of Gray's Inn Road, the greater portion of this improvement had been carried out, and the widened thoroughfare from Holborn to Clerkenwell Road was opened to traffic last April. Of the land devoted, under the Amending Act of 1882, to the erection of working-class dwellings, the first section only had been cleared. It consisted of three sites, all of which have been taken up, the total purchase money for them being 5,405*l*. for 999 years' leases at shilling rents. The Board had proceeded with a number of other improvements of a minor character in which satisfactory settlements had been made.

Parliament santioned fourteen improvement schemes previously to the passing of the act of 1882, and they were either completed or in various stages of progress. In order to test the practical working of the new Act, four new schemes were prepared, and having been confirmed by Parliament in the year 1883, were now being proceeded with; and two additional schemes had been prepared and deposited by the Board in the year just ended for the improvement of unhealthy areas in Deptford and Newington respectively.

With respect to bridges over the Thames, the report states that the foundations of the piers of Waterloo Bridge had all been deepened and secured. The Board in 1881 obtained power to build new bridges at Battersea and at Putney. The latter bridge was to be a broad and substantial structure of granite, the price agreed upon being 240,433*l*. 19*s*. Considerable progress had been made with the new bridge, and on July 12th last their Royal Highnesses the Prince and Princess of Wales visited it and laid a memorial-stone. A temporary bridge was also being built at Hammersmith at a cost of 82,177*l*. The failure of the attempt to obtain power from Parliament for providing means of transit below London Bridge is acknowledged.

The Board's expenditure during the year 1884. including 920,823*l*. advanced on loan to other local authorities, 1,602,672*l*. invested in Treasury bills, and 194,533*l*. applied to reduction of debt, had amounted to 5,373,170*l*., of which 1,961,329*l*. had been defrayed out of money raised by the issue of Metropolitan Consolidated Stock.—*London Architect.*

The Naval Observatory.

WASHINGTON, May 21.—Congress, by the act, of Feb. 4, 1880, authorized the construction of a new Naval Observatory; and a site for this purpose, on Georgetown Heights, was purchased soon after at a cost of $63,000. The condition of the old observatory was even at that time such as to urge a prompt appropriation of the money needed for the new buildings. Nevertheless, more than five years have elapsed since Congress took that step, and the new observatory has not been begun. The plans were made long ago, and were submitted to many leading men of science for comment before their adoption. The amount required for the construction is certainly not extravagant, being a little over half a million. Yet Congress has continually neglected to appropriate the money required.

Secretary Whitney has now taken an important step in the matter by referring the whole subject to the National Academy of Sciences, and the President of this body has intrusted its determination to a committee of seven distinguished members—Messrs. Barnard, Dana, Pickering, Young, Langley, Lyman, and Bell. They are to report upon it in season for action by Congress next winter, and are likely to review the whole subject, setting forth the comparative advantages of erecting new buildings on the new site and of reconstructing the old ones upon the present site, so that Congress cannot have the excuse of uncertainty as to what is most advisable for further delaying to do anything at all.

It is possible that the opportunity may be taken by the National Academy to discuss the question of a change in the administration of the observatory, or, rather, whether it shall hereafter be a naval observatory at all. Some men of science have strenuously argued that the institution, being essentially civilian, should be put under civilian management, and bills to effect this transfer have been from time to time brought before Congress. The naval officers, on the other hand, have usually resented this effort to take away from them an establishment of whose success they are naturally proud. The navy has the advantage of possession and of creditable management of the institution as it stands. It has also the argument from history in its favor. There can be no doubt that the observatory found its origin in naval necessities, and was established under navy officers. Still another argument is derived from the fact that there remains a great amount of annual work to do for the navy in this institution.

On the other side, it is strongly urged that the observatory has far outgrown its original scope; that its chief employment has now become purely scientific, and hence should not be subjective to military control, or to the changes involved in naval management. Within the past five years there have been four different superintendents. Rear Admiral John Rogers, whose death removed so ardent a friend of the observatory, Vice-Admiral Rowan, and Rear Admiral Franklin, now commanding the European station, preceded the present incumbent.

But, however this question of administration and organization is decided, the construction of the new buildings is really not dependent on it, and should receive consideration from Congress on its own merits.—N. Y. *Sun.*

Repairs of Drains.

The decision given by the Court of Appeal in Hugall *vs.* M'Kean on the 1st inst. is of importance to the owners of houses, as it confirms the necessity of special notice from tenants, before responsibility for defective drains devolves on landlords. The plaintiff is proprietor of a ladies' school at Blackheath, and in August 1882 agreed to take a house for three years from the defendant (a receiver under the Court of Chancery), who covenanted to keep the drains and sewers in good tenantable repair and condition during the tenancy. The defendant expended 50*l*. in repairs in accordance with a term in the agreement. On June 18, 1883, the basement was suddenly flooded with sewage which forced itself up the traps. The plaintiff immediately called in a sanitary engineer, who found the drains in a defective and dilapidated state. Among other defects a 4-inch pipe was connected without any cement with a 9-inch pipe, leading from a cesspool, and the sewage was oozing from the joints; also the soil-pipe passing through the house was corroded and leaking with sewage. It was alleged that the flooding was due to the pressure from the cesspool. The plaintiff, without notice to the defendant, immediately did the necessary repairs, and sought to recover the cost (50*l*.) from the defendant. The defence was that the plaintiff should have given notice to the Court of Chancery of the want of repairs, and the Chief Clerk said he was unable to allow anything which was not legally due. It also appeared that the plaintiff paid the midsummer's rent without any complaint, and that no notice was given to the defendant until September.

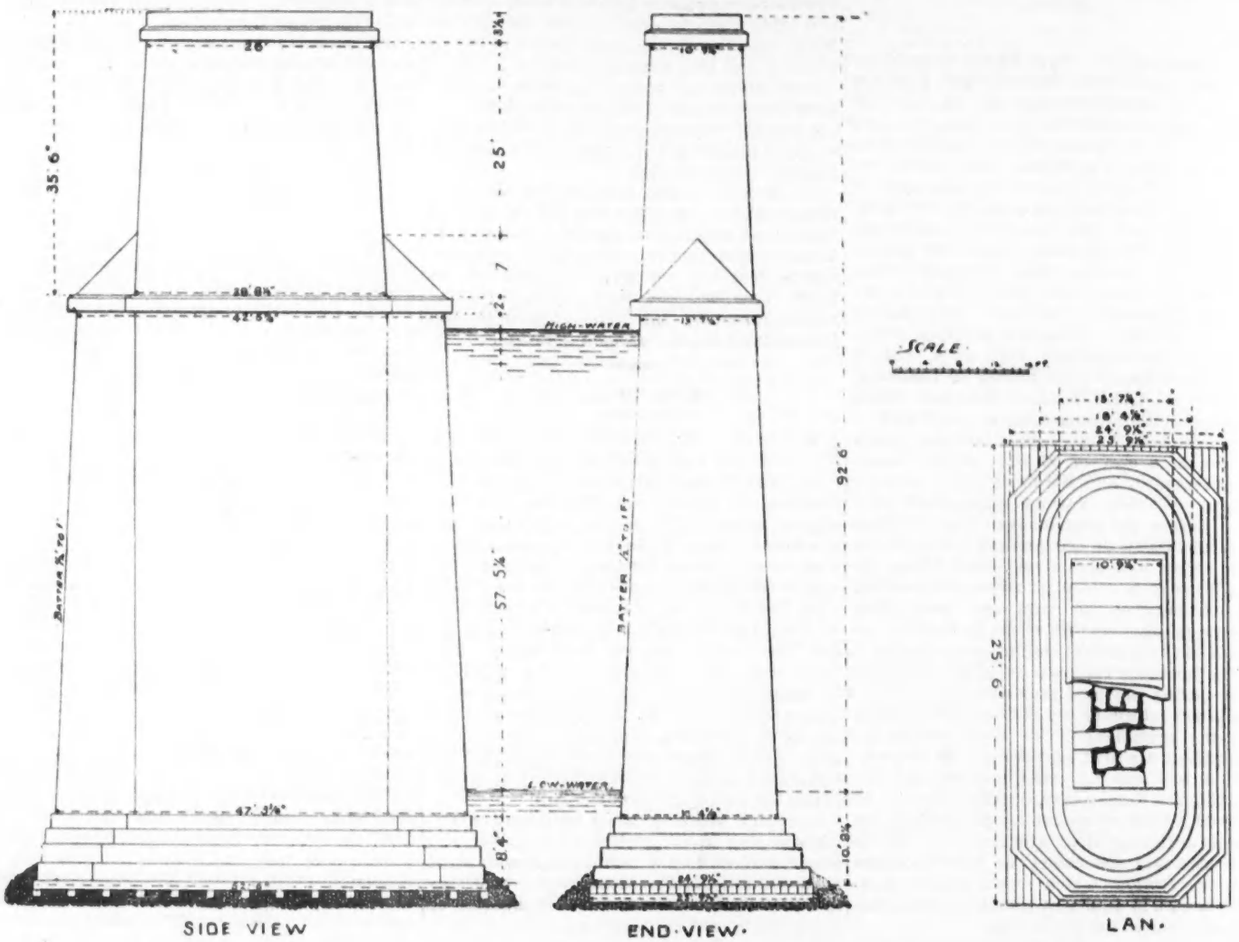
At the trial before Mr. Justice Wills, the jury found that the plaintiff did not know, and had not the means of knowing, that the drains were in a bad condition prior to June 18, 1883; that the defendant did not know, but had the means of knowing, that the drains were in a bad condition prior to that date. On those findings Mr. Justice Wills entered judgement for the defendant, whereupon the plaintiff appealed.

The Master of the rolls, in dismissing the appeal, said that the terms of the covenant were substantially the same as those construed in "Makin *v.* Watkinson" (L. R. 6, Ex. 25). The effect of that decision was that into such a covenant there should be imported the condition that the landlord shall have notice of the want of repairs before he can be called on under the covenant to make it good. But the plaintiff could not say that the landlord had such notice. In the circumstances his lordship thought that the case was hard on the plaintiff; but it was not cruel, because the Court of Chauncery had to consider the rights of the other persons interested in the administration action. Their lordships must abide by the law, and say that the judgement should be affirmed.—*London Architect.*

PARIS possesses one remarkable street which has neither doors, windows, numbers, nor sign posts. It runs from the Rue Beauregard, and has the distinction of being the shortest street in Paris and probably in the world. Its total length is about sixteen feet.

ENGINEERING NEWS Three months for One Dollar.

PT. PLEASANT BRIDGE: PIER AND FOUNDATIONS.



The Point Pleasant Bridge, W. Va.

Written for ENGINEERING NEWS.

BY COL. WM. M. PATTON.

As stated in a previous article (ENGINEERING NEWS, March 14 1885), the O. C. R. R. bridge was divided into five spans with six piers. The two land piers were built upon piles, as they were near the river and located upon banks that were gradually being undermined and were thus subject to slides.

Pits were excavated to a depth of 15 to 20 feet, and in these piles were driven 2 feet, 10 inches apart from center to center. These piles were cut off about 1 foot above the bottom of the pit, and concrete rammed in between them. Pine caps 12 × 12 inch were bolted upon the pile heads, and concrete filled about them; upon these caps was finally placed a solid flooring of 12 × 12 inch, Michegan pine, bolted. The masonry was commenced upon this platform and concrete was rammed around the masonry to the top of the first course to further protect the timber beneath. As many engineers claim that timber thus encased in concrete is as durable as if it were under water, this arrangement of the foundation provided for any future washing away of the banks at this point, when a simple rip-rap to prevent further scour would be sufficient to protect the pier. But as experience at other points on the Ohio River prove that a stone slope paving will prevent the washing away of the banks, this rip-rap will be practically unnecessary.

Pier No. 1, on the east bank, was commenced May 8th, 1882, and completed on July 8th. Pier No 6, on the west bank, was commenced about April 1, and completed July 12. The river piers were put in as described in the previous article. In all of these river piers the gravel and sand was excavated and a pit varying from 2 to 3 feet deep was cut in the underlying compact clay; small ditches around these pits inside the coffer-dams kept the enclosed space perfectly dry. Holes bored into this clay showed it to be hard, difficult to remove even with a pick, entirely impervious to water and capable of carrying any load the bridge could bring upon it. The foundation was commenced upon this by first laying down a layer of concrete one foot thick and then cross-timbers 12 × 12 inch placed with 2 feet intervals between, filling these spaces with concrete and finally laying a solid floor of 12 × 12 inch sticks. This plan was followed out in all the river piers. In piers 3 and 4, the depth of gravel overlying the clay being only from 5 to 6 feet deep, the inner cribs (described in previous article) were not used. Instead of this a frame of two sets of 12 × 12 inch timbers placed one on top of the other were put in position, and to this was bolted 3 × 12 in. wale-pieces with a 3-inch space left for driving sheet-piling between it and the 12-inch timbers. This sheeting was driven down as the excavation progressed, the broad face afforded by the double sets of heavy timbers preventing the sheeting from being pushed inward by the pressure of the outside gravel and sand, all of which material was shovelled from within into the space between this sheeting and the coffer-dam. This method was found expeditious, economical and very successful. The idea suggested itself from an expedient alike in character adopted to check an inrush of gravel under the cutting-edge of the inner crib of Pier No. 5. This method has been patented by Mr. J. E. Robinson, and is one of the principle features in his coffer-dam which was used in Pier No. 5, of the Havre de Grace Bridge.

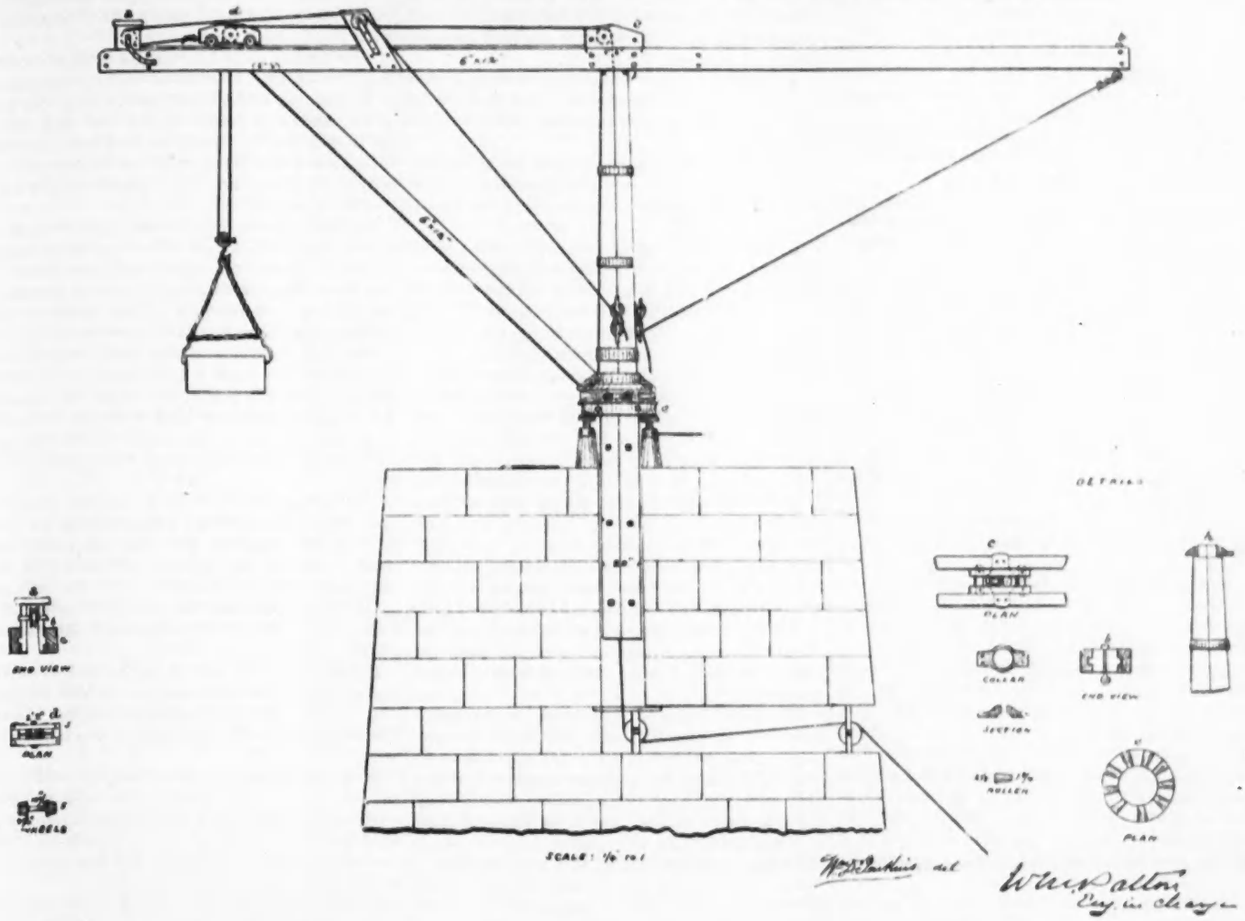
The masonry of this bridge was completed by July, 4, 1883, and the general progress made was far ahead of any other bridge previously constructed over the Ohio River, approaching it in length of structure and height of masonry. In less than 12 months, four foundations in water were completed, and all the masonry ready for the superstructure, including a considerable quantity of pedestal masonry for the iron viaduct approaches. The erection of the bridge was commenced in June, 1883.

The figures following give the quantities of material of all kinds and the cost of the foundations:—

Pine timber in cribs inside of coffer-dams and foundations	273,210	ft. B. M.
Oak timber in coffer-dams, main and sheet piling	244,412	"
Poplar timber in above	3,597	"
Round Piles in foundation and coffer-dams	13,571	lin. ft.
Excavation in foundations	4,342	cu. yds.
Concrete " "	649	"
Rip-rap	997	"
The total cost of foundations, including labor of all kinds, derricks, barges, engines, pumps, iron, tools, ropes and everything necessary for the rapid completion of the work, was		$64,652.62
The masonry in piers (8,654 c. yds.) cost		123,756.92
Foundations and pier masonry		$188,409.54
1,324 cu. yds. Pedestal masonry		15,912.
Excavations for pedestals		2,304.02
39,490 cu. yds. earth embankment in approaches		8,687.80
371,962 ft. B. M. in Timber trestle		11,158 86
11,965 lbs. Wrought-iron in "		598.25
7,939 lbs. Cast-iron in "		317.56
Extras of various kinds		174.64
Total cost of foundations, masonry and approaches		$227,562.67

The last given amount includes everything but the cost of the iron superstructure, or bridge proper and the iron viaduct. The bridge was constructed on a grade, falling each way from the channel span, of 0.5 feet eastward,

PT. PLEASANT BRIDGE: DERRICK USED IN BUILDING PIERS.



and 0.25 feet westward, in 100 feet. The grade on the viaduct and approaches on each side was, 1.5 feet per 100 feet reduced to 1.25 feet on the 5° curve on the east side. The length of the iron viaduct on the east side was 1514½ feet, on the west it was 951⅝ feet.

The accompanying drawings give the elevation and plan of piers, and foundations, and details of the hoisting plant. The masonry was built with an ordinary floating derrick, until a height of about 40 feet above low water was reached; above this point a derrick was built in the pier and carried up with it as shown in the illustration. The stone used in the masonry was principally Hocking Valley sandstone, and sandstone from a quarry on the Kanawha about two miles above the bridge.

In selecting the material for this work samples of stone from various quarries were procured, and carefully cut into cubes of 2 inches on the sides by an ordinary stonecutter. These cubes were then sent to a marble yard in Columbus, Ohio, and there further dressed to as true surfaces as was possible. Then cushions of white pine were cut out to fit the cubes, and the blocks were then tested for resistance against crushing, at the Ohio State University at Columbus. The white pine cushions were placed on top and bottom to insure a full and uniform bearing.

The results of these tests are given in the following table:—

Location of Quarry	Number of Specimens	Cracked or gave slight indication of yielding: Pressure per cube	Cracked or gave slight indication of yielding: Pressure per square inch	Crushed or split: Pressure per cube	Crushed or split: Pressure per sq. inch	Remarks
	No.					
Hocking Valley	1	4800 lbs.	1200	18458	4614½	without violence or noise
" "	2	23526 "	5881⅜	27885	6971⅛	little noise
" "	3	6650 "	1662½	12000		taken out, but, not crushed
" "	4	8130 "	2032½	15930	3982½	
" "	5	17620 "	4405	17620	4405	no evidence of yield'g until crushed
" "	6	18740 "	4685	18740	4685	crushed without notice
Miller Quary on Kanawha Riv. 2 miles above Pt. P.	1	.....	.....	14942	3735½	no noise
"	2	.....	.....	15442	3860½	crushed suddenly, without cracking or splitting
"	3	4854 "	1213⅝	13610	3402½	crushed with violence
near Pt. P. Old Saw mill near Pt. P.	1	18000 "	4500	18000	4500	suddenly and with violence
Fisher's Quarry on Kanawha River near Charleston	1	5630 "	1407½	8000	2000	fresh and on edge by mistake
Scanny Creek	1	.....	.....	22000	5500	without notice and with violence
" "	2	12000 "	3000	14000	3500	
" "	3	.....	.....	14150	3537½	crushed suddenly and with violence
on Kanawha River near Buffalo	1	.....	.....	19200	4800	without notice
Kanawha River eight miles above Pt. P.	1	.....	.....	21878	5469½	" "

Specimens from the above quarries are given out of a large number tested. The specific gravity, weight per cubic foot, and ratio of absorbtion of water were also given. The sandstones found along the Ohio River are generally inferior to those on the Kanawha, and the higher up this last river the better the sandstone, until near Charleston, W. Va., the tests made by the U. S. Government show the sandstone there found exceeds in resistance against crushing almost any found elsewhere in the United States.

It is hardly necessary to remark that the resistance of sandstones will vary materially in specimens taken from the same quarry; and this variance depends mainly upon the length of time the specimen has been quarried, or what is the same thing, the time in which it has been exposed to the action of the atmosphere. The Hocking Valley sandstone has the color of brown sugar, is exceedingly soft when first quarried, but hardens rapidly on exposure to the air. An examination of this stone, where it has been used in piers, dams and buildings, in the Hocking Valley, for over half a century, shows in many cases the tool marks still intact, and it was this evidence of endurance that determined its use in this bridge. The stone from the Millar quarry, on the Kawawha River also used, showed a sharp, close grain, with a minimum of cementing material and sharp, well-defined angles on long exposed surfaces in the quarry.

THE manufacture of steel nails has made rapid progress since 1883, in which year this industry may be said to have had its beginning. During last year there were 393,482 kegs of steel nails manufactured, the production of three leading nail-making states being as follows: West Virginia, 204,336 kegs; Ohio, 130,636 kegs, and Pennsylvania, 29,324 kegs. In 1883, this country produced only 18,224 kegs of steel nails.

Pumping Machinery for Water-works.

BY FRANK H. FOND, MEMBER OF THE ENGINEERS' CLUB OF ST. LOUIS.

Read May 13th, 1885.

Running streams afforded the most primitive natural water supply, but wells existed in the earliest historical ages. Then came the plan of leading water to a distance by artificial inclined channels, which culminated in the magnificent acqueducts of Rome.

The first introduction of water supply into houses by pipes under pressure, was in connection with the London Bridge Water-works, established in 1582.

The earliest water mains were of lead or of wood, but it was not till cast iron came into use for this purpose, about 1810, that the water supply of towns began to receive its full developement.

The introduction of pumping machinery for domestic water supply, dates from May 30, 1581, when Peter Maurice was granted a lease, to erect an engine within the first arch of London Bridge, for the purpose of supplying that city with water. These works proved so successful that he was granted the privilege of erecting another engine in the second arch of the bridge.

His pumping machinery consisted of an undershot wheel, twenty feet in diameter, having twenty-six floats, fourteen feet long by eighteen inches broad. Each wheel gave motion by means of toothed wheels and levers, to sixteen pumps, in such a manner that for every revolution, the plungers made two and one-fifth strokes, two feet six inches long. The plungers were seven inches diameter, and when the tide flowed quickly the water wheels made about six revolutions per minute. Making no allowance for "slip," the two wheels would together be thus pumping at the rate of about two and one-half million gallons in twenty-four hours.

The history of the steam pumping engine commences with the atmospheric engine, which is known as the Newcomen type. This is single-acting, the steam raising the piston, and the atmosphere forcing it down where a vacuum is formed by condensing the steam below the piston. This was improved upon by Watt, who substituted for it, first, his single-acting engine without a crank; and afterwards his double acting; but its greatest developement has occurred during the present century.

The oldest water-works in the United States are supposed to be those at Bethlehem, Pa., which were built in 1754, by Hans Christopher Christiansen, a millwright, a native of Denmark, and being of historic interest, we will enter into a description of it, somewhat in detail.

The water was taken from a spring issuing from magnesian limestone, near the banks of the Menogassi Creek, as it was then called. The water was conducted three hundred and fifty feet through an underground conduit into a cistern, whence it was pumped by a lignum vitæ pump of five inches bore, through bored hemlock logs, to a height of seventy feet, into a wooden tank in the village square. Trouble was experienced from the bursting of the pipes, and one and one-quarter inch pipes of sheet lead, soldered along the edges, and bedded in a cement of pitch and brick dust and laid in a gutter, were tried without much success.

In 1762 Christiansen, aided by John Arbo and Marshall, constructed larger works. An eighteen-feet undershot wheel drove three single-acting force pumps of iron of four inches bore and eighteen inches stroke. The force main was of gum wood and the distributing pipes of pitch pine. The latter had to be renewed in 1769.

In 1786 lead pipes were substituted for the gum wood force main and for most of the distributing pipes. The last pitch pine pipes were abandoned in 1791. The reservoir was a wooden tower in the "little square." This was removed in 1803 and a stone tower built on Market Street, about fifteen feet high, in which was a tank, at an elevation of one hundred and twelve feet above the spring.

In 1883 a reservoir was constructed on higher ground and the water tower abandoned. Also the triple pumps were replaced by one double-acting pump.

In 1868 steam power was used for pumping. In 1874 the wooden conduit from the spring to the pump-house was replaced by an eighteen-inch iron-pipe.

Until the year 1800 there were in the United States, including Bethlehem, only eight water-works, as follows, in the order of the year of their construction: Providence, R. I., 1772; Salem, Mass., 1796; Geneva, N. Y., and Portsmouth, N. H., 1797; Worcester, Mass., 1798; Morristown, N. J. and Peabody, Mass., 1799.

From 1800 to 1810 there were eleven water works built, from 1810 to 1820 seven, from 1820 to 1830 thirteen, from 1830 to 1840 eighteen, from 1840 to 1850 twenty-five, from 1850 to 1860 fifty-six, from 1860 to 1870 one hundred and three, from 1870 to 1880 three hundred and eighty-one, from 1880 to January 1st, 1885, there were finished or in progress four hundred and twenty-six, making a total of 1,040 towns known to have water-works in the United States and Canada to January 1st, 1885.

Of these 1,040 water-works, 355 are supplied by gravity, 649 by pumping, and the mode of supply in 36, we have not yet been able to ascertain.

The proportion of water-works in which water is pumped by steam is rapidly increasing, and the subject of pumping engines to do this work is becoming more important every day, but the conditions under which they operate are so varied, that it is impossible to go into details in this paper, and we shall therefore treat the subject in a general way.

The first requirement of a pumping engine is, that it must be able to pump water, under the peculiar conditions which it has to work, and to do this continually, successfully and economically.

Its ability to operate day after day, year after year, under the varied requirements of the service, with the least possible expense of repairs and delays, is the most essential fact to be taken into consideration; but, at the same time, it must be capable of easy management and take care of itself to a great extent after being properly adjusted and started at its work.

The second requirement is economy of steam. Economic use of steam is of course important and desirable, but it must not be accomplished at too great expense of repairs and the necessity of continual attention and adjustment on the part of the attendant.

The cost of a pumping engine is another important consideration and is the "stumbling block" of water-works companies and committees generally, when a few thousand dollars more of first cost has many times outweighed the above mentioned qualities, and it has been demonstrated to their sorrow and cost, that to own some pumping engines is sufficient to bring great loss and almost ruin, even if the engine had been taken as a gift, on account of the bills for repairs, which are contracted, that things may be kept moving.

Pumping engines may be divided into two general classes—crank and fly-wheel or rotation, direct acting or non-rotation, and are made of almost endless variety as to details, the particulars of which we do not care to enter into in this paper.

Just where we shall draw the line, that a crank and fly-wheel engine should be used and not a direct-acting engine, appears to be debatable ground, and where engineers, like doctors, disagree. It therefore behooves us to handle this part of our subject with great care, and endeavor not to tread on the toes of any pumping engine manufacturer.

The history of pumping engine construction commences in this country, as in England, with the Cornish engine.

This engine gave fine results in the department in which it originated—mine pumping.

The engine being inordinately large for the work, making a casual stroke now and then, as demanded by the flow of water into the mine, the water being delivered at the surface with no force main, there being no demand for uniform flow.

A glance at the conditions under which it works will explain the otherwise unaccountable fact a pumping engine without a rival in one place has a failing reputation in another. Its honors were never qualified until it was transplanted from the home of its usefulness to do duty in a service where water was to be discharged through a long main to a great height above the pump, and under the requisition of continuous and uniform delivery This was the very requirement which from its nature, the Cornish engine was unfitted to meet.

The Cornish engine is in its nature precarious, requiring constant watchfulness on the part of the engineer and can not safely be trusted for a minute without this care and supervision. This uncertainty of its action, great first cost and expensive repairs has finally lead to its abandonment for water-works.

The crank and fly-wheel engine was the first and most obvious alternative. While emulating the economy of the Cornish engine, it was positive in its motion and safer in its character.

In the crank and fly-wheel engine, steam is cut off at a certain fraction of the stroke, while the remainder is finished by expansion, aided by the momentum of the fly-wheel, thus producing great economy in the use of steam at the expense of intricate machinery.

These engines operate either vertically or horizontally. They require expensive and massive foundations to absorb the shocks and jars incident to their working, this being especially true of vertical engines, the momentum of the fly-wheel in its revolutions, increasing to a large extent the accidents hat would otherwise be trifling.

The use of direct-acting steam-pumping engines in water-works dates from about 1854, and it was brought in direct competition with the Cornish and crank and fly-wheel engines, in the extensive trials of duty, made in 1857 and 1859, which were the most important that had been conducted in this country up to that time. The results are contained in the following table.

CHARACTER OF ENGINE.	LOCATION.	UTY.
Horizontal Direct-acting	Cambridge, Mass	67,257,900
Cornish	Belleville, N. J.	62,823,300
Crank	Hartford, Conn.	61,640,400
Double-acting Beam	Brooklyn	60,140,700
Cornish	Phiadelphia	58,905,300

The Cambridge engine was erected in 1856, and is a single compound condensing engine, of only 300,000 gallons capacity in twenty-four hours.

An improved form of this engine, known as the duplex, was erected at Charlestown, Mass., in 1863, having a capacity of 5,000,000 gallons in twenty-four hours, under a guarantee of performance equal to that of any engine in the Untied States.

It succeeded and was followed by another of 5,000,000 capacity in 1867, and still another of 8,000,000 capacity in 1872, in the same works. The duplex engine has since been more extensively used for water works purposes than any other.

The duplex engine is horizontal in action and usually allows the steam to follow th-

piston throughout its stroke, thus preserving great simplicity and compactness in working parts. The foundations required are much lighter and less expensive than that for a crank or fly-wheel engine.

The duplex engine is essentially two direct-acting pumps placed side by side, their valve motions being so arranged that the motion of one pump acts to give steam to the other, after which it finishes its own stroke and waits for its valve to be acted upon before it can renew its motion. This pause allows all the water valves to seat quietly and removes everything like harshness of motion, keeping up a uniform delivery, without pulsation or noise.

The smoothness of motion and simplicity in steam valve mechanism, reduces the liability of accident to a minimum.

While it is not claimed that the compound condensing duplex engine is capable of developing the highest duty, their yearly records are excellent, ranging from 50,000,000 to 65,000,000 duty, and trials have been reported as high as 77,000,000.

It is claimed for these engines that their moderate first cost—engine proper, foundation and building, as well as inexpensive repairs, and small expense of replacing any important part, makes them in a majority of cases the most economical to use.

Until 1873, a duty of 60,000,000 foot-pounds per 100 pounds of coal was rarely exceeded.

In July, 1873, a trial was made of the crank and fly-wheel engine at the Lowell Water-Works, and a duty was obtained of 93,002,272 foot-pounds.

In December of the same year, a trial was made of the crank and fly-wheel engine at Lynn, Mass., and a duty was obtained of 103,923,215 foot-pounds for every 100 pounds of coal fed to the furnaces.

In October, 1878, the Pawtucket, R. I., crank and fly-wheel engine was tested and there was obtained a duty of 104,357,654 foot-pounds.

In May, 1882, the crank and fly-wheel engine at the Pettaconsett Water-Works in Providence, R. I., developed a duty on a six days' test of 113,271,000 foot-pounds per 100 pounds of coal, reckoned on the coal consumed, including the wood used in starting fires.

It is proper to state that these last two engines work at high speed and require steam at from 125 to 130 pounds pressure.

These high duty engines are expensive in first cost, not only of the engine, but in foundations, the cost of which is frequently as large as that of the engine itself, and for the building, also for attendance, maintenance, etc., and unless constantly worked up to their full capacity are much less economical to run than the duplex engine and when repairs are necessary, it involves a large outlay.

A comparison of first cost between crank and fly wheel engines and duplex direct-acting engines is given in the tables below, and are prices which were bid within the past two months at a public letting:

ENGINES OF 10,000,000 GALLONS CAPACITY IN 24 HOURS.

STYLE.	Duty Guaranteed.	Cost Engine and Foundations.	Speed of Piston per min.
Crank and Fly-Wheel	105,000,000	$71,000.00	140 ft.
Duplex	70,000,000	33,800.00	100 "

ENGINES OF 5,000,000 GALLONS CAPACITY IN 24 HOURS.

STYLE.	Duty Guaranteed.	Cost—Engine and Founda-	Speed of Piston.
Crank and Fly-wheel.	100,000,000	$46,000.00	140 ft. per min.
Duplex.	70,000,000	20,425.00	112 " "

Duty is based on an evaporation of 10 lbs. water per pound of coal.

The cost of repairs on a pumping engine is quite an item, and must not be overlooked.

ENGINES OF 5,000, GALLONS CAPACITY IN 24 HOURS.

STYLE	Cost Engine and Found'n	Tons of Coal Evap. 10. to 1.	Tons of Coal Evap. 6 to 1.	Cost Coal per year Evap. 6 to 1.	6 per cent. interest on the plant.	Repairs.	Total annual cost of pumping 5 mil. gal. per day.
Crank and Fly-wheel	$46,000	1,712.31	2,853.84	$1,195.14	$2,760.00	$800.00	$7,755.14
Duplex.	20,425	2,446.14	4,076.89	5,993.03	1,225.50	11.90	7,230.43

The builders of the high duty crank and fly-wheel engines which we have taken as examples, state they will guarantee to keep them in repair for two (2) per cent. of their cost per year; this would amount in the case of the 5,000,000 gallon engine, the cost of which without foundation is $40,000, to $800 per year, and would amount in ten and one-half years to $8,400.

We find from the public record of two (2) 5,000,000 gallon duplex pumping engines, which have been in constant service for ten and one-half years, the total cost of repairs of every description amounts to only $250 or $125 for each engine, or $11.90 per year.

Another fact that must be considered in making this comparison of pumping engines is, the cost of replacing any important part of it.

We know of a crank and fly-wheel engine of 5,000,000 gallons capacity, of a well-known make, and which has a published duty record of "101,310,937 foot pounds," that has cost about $6,000, for repairs during the two years since it was started, which shows that any important part of a crank and fly-wheel engine is expensive to replace, while in the duplex engine there is no single part which could cost over $500 *to replace.*

The evaporation of ten pounds of water per pound of coal is generally taken as the basis when comparing the duty of pumping engines. We find 6 pounds of water per pound of bituminous coal is about the best result obtained in regular practice with steam boilers in the West. This is the yearly record at the St. Louis Water-works.

We also learn the yearly contract to furnish coal for these works for 1885, is $5\frac{89}{100}$ cents per bushel of 80 pounds, which would be $1.4725 per ton of 2,000 pounds delivered, or say $1.47 per ton.

Therefore we will use this data in our table of comparison given below, that the results may be compared with those of daily practice.

The total head pumped against being 225 feet.

A crank and fly-wheel engine requires more constant care of the attendant, than a duplex engine. Where a duplex engine is run constantly, a cheaper man is delegated to take care of it at night, and in many cases, it is allowed to take care of itself, the fireman attending to oiling, it being less liable to accident, thus dispensing with a night engineer, which would still further reduce its annual cost.

In concluding, I trust that I have brought out a few points which may be of interest to you on the subject of Pumping Machinery for Water Works, and hope you will see the importance of taking all the facts into consideration when, as consulting engineers, you may be called upon to decide which engine is the best to purchase, and remember there is something else besides "high duty," for it may cost too much to select it. Its value must be based on the saving of fuel, as balanced by the interest on the cost of the plant, cost of repairs, extra cost of attendance, and liability to accident. If the total saving in current expenes shows on the right side of the ledger, a high duty pumping engine is a good investment, otherwise it is not.

THE mean elevation of this country is estimated at 2,600 feet above the level, and the average rainfall at twenty-nine inches.

Fuel-Economy in Engines and Boilers.

BY P. BARNES, NEW YORK CITY.

(Read at the New York Meeting, February 1885.)

It cannot be said that this whole subject is a new one in respect to its presentation to the Institute, but the minute discussion of it has been looked upon as lying more strictly within the field of study of the societies which have to do chiefly with the construction and management of machinery as such. It must be true that the importance of close limits in steam-economy is as fully recognized among the members of this Institute as by any body of men who have to do with steam-machinery In all directions, nevertheless, among manufacturers as well as among metallurgists, there may still be found those who do not give the same attention to exact methods in fuel-consumption as devoted to steam, as to other technical uses which, to say the least, are not more important.

The study of the most efficient methods of use of fuel in operations which are more strictly metallurgical has been long-continued and in some directions nearly or quite exhaustive. This has led to a rather close bringing up, in those particulars, all along the line of technical work, of the establishments (and their managers) which had lagged behind. Yet, in the steam departments of those works, there are too many reasons, for believing that the name may still be legion of those whose methods and results are far from the best.

If there be room in any given case to suspect any imperfect working or use of fuel in the steam-supply, the search for the evil, the clear fixing of its cause, and the application of the remedy are, or certainly ought to be, too obvious in their pressure for attention upon a manager to call for even so scanty a mention of them as can be accorded in this paper. It is natural that men should be incredulous as to imperfections which may be noted as existing in their machinery or methods. Still more are they likely to be altogether disinclined to admit that there may be thus an actual and palpable leakage in the compartment of their money-drawer devoted to coal-supplies. The laws which govern the combustion of fuel, the absorbtion of heat by water, and the utilization of the heat thus transformed to an engine, are too exact, however, to permit any respect of persons. Those only who assure themselves, by rigid and frequent tests, that their work goes on in conformity to these laws, can rest content that they do not somewhere suffer loss unawares.

Among the evils which are likely to be encountered in existing machinery are chiefly those due to old and worn fixtures, and these are too often an unprofitable inheritance handed down to present managers from an early day. Even if it were true (and it is very far from true,) that it is good policy to tolerate wasteful steam-machinery in preliminary work, merely because it is supposed to involve a less first cost, the importance may still be justly urged of providing at the earliest moment the higher-class fixtures and machinery. Stern necessity itself ought to suggest and compel the entire abandonment and replacement of antiquated or wasteful apparatus, on the instant of the assuming by

*Transactions of the American Institute of Minin Engineers.

the enterprise in question of any definite or permanent character. The use of high-class steam-machinery ought to be more fully recognized as a vital element of this permanence, even in the most modest undertaking. There are certainly enough establishments to be found whose stability is based upon their closely studied steam-methods to warrant the strongest statements of the obligation resting upon managers, to see that their practice in this respect is equal to the best. The standards of excellence admit of the clearest definition, and in those lines, as in most others, the best is at least as good as any, and when once rigidly and patiently sought for, is not difficult for attainment.

So far as the steam-engine is concerned, and the use of steam in it, upon which so large a proportion of our operations depend for prime movement, the study of its condition must be followed along two lines. One is obviously the general external condition of the engine as a whole, whether it is accurately maintained in line and level, and is properly cared for in respect to lubrication, and general connection and adaptation to the work to which it is applied. The other line of study is internal, and is likely to be far more important. Deviations from the right path in this respect in the use of steam, and the fuel upon which it depends, are unseen by the casual observer, and are not always detected by an expert, except after an expenditure of time and patience which, to some owners, appears quite uncalled for and absurd. The *indicator* is the sole means by which this internal study of the working of an engine can be carried on, and though the most skillful use of this instrument may not invariably lead to relief from all the ills to which engine-flesh is heir, yet it has been found, in countless instances, a means of averting loss which would have proved quite fatal, as measured by a money standard.

It may be quite needless to say that the sole office of the indicator is to record the pressure in the engine-cylinder, at each point in the motion of the piston. An outline may thus be drawn which can be compared with standards established by long and exhaustive computation and experiment. Thus the correctness of the working of an engine can be determined, as depending upon the original construction, and the current adjustment of the parts. With older types of engine it frequently happens that a correct distribution of the steam in the cylinder cannot be effected, as called for by the varying loads under which the engine must expend the money paid out for coal or other fuel. When such cases are discovered (and too often their existence remains unsuspected for years,) the best remedy is generally a radical one, *viz.*, the entire replacement of the engine by one of modern build. Thus many refined elements of design can be brought into service, simple and trustworthy in the highest degree, which may secure this correct use and expenditure of the steam which must be paid for.

Next to this entire replacement, may be named the rearrangment of the parts concerned in the steam-distribution, so that their functions shall be more correctly discharged. This is practicable in many cases, and some notable improvements have been effected, by means which have appeared trifling in kind, but, when gauged by the money-saving effected, have shown a value of no mean degree. The possibility of such rearrangements should obviously be more carefully studied in a time of depression, when the call for economy is stringent, although the way may be hedged in too closely to permit more than the most fragmentary improvements. By such simple means it is sometimes practicable to bring up the indicator-diagram of an old engine to an extremely close approximation to the standard outline referred to. Thus there may be found remaining, in this respect, very little to be desired, and nothing farther to be accomplished, except by the additional and more radical means of an entire replacement.

In this connection, mention should be made of the advantage which, in respect of fuel, attends the use of the compound engine. This type, in few words, secures the utilization of the heat developed by the combustion of the coal within wider limits of temperature than the simple engine, and hence of a larger proportion of this heat. This use of temperature is divided, in the engine, into parts or grades, so that the higher limit shall not be interfered with, or impaired in its expenditure, by contact with the lower. The use of three cylinders is common in the higher class of marine engines, so that these successive steps in the expansion of steam shall be fully provided for and correctly taken. It is a noteworthy fact that the exact possibilities of these close limits of economy have been most clearly shown in marine engines, in which, as a rule, the restrictions as to space and dead-weight of machinery are extremely close, and in which the possibilities are, therefore, the least of choice of arrangement of parts for obtaining the best result. It may also be noted in this connection that the objection, so frequently urged, of a supposed complexity in the compound engine should have weight enough, if it has any at all, to have prevented the adoption and wide application of the compound engine for sea-service. The exigencies of this service are more stringent, if possible, in respect of simplicity of parts and certainty of operation of the machinery, than in the limits of space and weight which are admissible; yet it does not appear that time is lost, or that exact days and hours of sailing are missed, by reason of the complexity of the engine-fixtures, for years at a time.

The increasing use of this compound type of engine, already so highly perfected, suggests the remaining topic of this paper, *viz.*, the absolute call for higher initial pressures for the small or first cylinder of the engine. A limit of 160 pounds has long been carried on locomotives, and constitutes an important element in the economy of their performance, which is very marked, in spite of the obvious limit of space and weight which must be so closely observed in them. Few things can be named, perhaps none whatever, which will prove so definite a help in the study of economic working of steam as a large increase of boiler-pressure,—an increase, in fact, which shall border closely on the limit at which, in the present state of the art, the lubrication of the engine-parts becomes the chief question. This limit is not reached at a pressure of 300 pounds and hardly at 350 pounds. The addition is very important, which may thus be made to the range of temperature within which the steam may be used as a medium for the transformation of heat into work. The proportion is correspondingly reduced of the losses from radiation which must be tolerated, and of imperfect condensation, at the foot of the scale of pressure to which the steam is finally brought.

This call for higher pressures must be met, and can be more fully met by a radical departure from accepted forms of boilers than in any other way. This change of form need not introduce into the art of boiler construction any untried features, for the compact box form, which is now offered for consideration, based on the designs of Mr. Allen Stirling, of New York, was in some respects the earliest known for steam-boilers. In locomotives it has been continuously employed, and the absolute limit of track-gauge is leading to a wider use of the flat, stayed surface for the high pressures now so common in locomotive practice. The possibility, thus rendered complete, of a safe dependence upon the tensile strength of stay-bolts is of the highest importance. No combination of riveted joints can be made which shall not depend, in large part, upon such staying of flat surfaces, and the interest of safety and economy in high pressure construction clearly points to an abandonment of unstayed surfaces of any description.

Another essential point in boiler-construction should be named, since it is of vital importance in the maintenance of the strict economy of operation which this paper aims to promote. This is the need of a large, separating surface at the water-level within the boiler, at and through which, over its entire area, the steam may be quietly liberated from the body of water within which, in minute bubbles, it is generated. This is needful in order that the quantity of heat tran ferred from the boiler to the engine may be simply, and only, that due to the quantity of steam withdrawn, and not that far larger quantity also, which is due to the presence in the steam of even a small fraction of suspended water. This water, when thus led away, acts as a hurtful absorbent of the heat developed in the burning of the coal, and this proportion of heat is wholly lost, so far as the subsequent production of useful work is concerned.

The adoption of a flat-sided box-outline, with stayed surfaces, for the body of a boiler, clearly suggests the use of water-tubes for heating-surface, which shall be wholly external to the box, and thus fully exposed, not only to the radiant heat of the fire, but also to the sharp contact of the currents of heated gas from the fire. In other words, the work of the boiler should be done by the exposure of the whole of the tube-surface to a quiet bath of intensely heated gas in an enclosing brick chamber, from which there shall be withdrawn, through a close damper, only so much of this gas as shall insure the maintenance of the whole at the full intensity due to the limit of pressure which must be preserved

This combination suggests to the experienced man the simple drop-tube, so long and favorably known, with the internal feeding or circulating tube, by means of which the *tidal* circulation shall be maintained within the boiler which secures the persistent sweeping of the heated surfaces with large volumes of solid water. Thus the bubbles of steam are pushed up into the steam-space, and the hot tube surfaces are kept covered with compact bodies of water in the best form to insure the prompt and most complete absorption of the heat from the gas which envelopes the tubes. Thus it becomes possible to construct a boiler up to a capacity of several hundred horse-power, in which the pieces of plate employed need not exceed four in number, and in which also the stays shall be of the simplest, most fully approved kind.

Brief mention may be permitted of the possible need of greater watchfulness in the prevention of incrustation in boilers which are designed for higher pressures, and which must be therefore subject to a higher heat. Obviously the time-honored remedies or means of prevention for this persistent evil are as applicable to this case as to any, however new may be the details of experience or management likely to be developed. This important consideration is worth of note; that if the work of the boiler as a whole is done so economically as it may be through the use of the compound engine, a much larger loss of heat may be reasonably tolerated through a more frequent blowing-down and refilling of the boiler hour by hour, as the advancing saturation of the water may indicate. It is certainly true, that if as much care and exact attention were devoted to this blowing-down during working-hours as is given by a skillful attendant to the feeding, some handsome gains of safety and durability would be made. No just reason can be given why this should not be expected and rigidly insisted upon, whatever may be the pressure carried or the amount of work done by the boiler, so long as there is the slightest reason for suspecting the presence in the feed water of any appreciable proportion of incrusting matter. It is clear, how-

ever, that only the least useful result can attend the somewhat common practice of feeding and blowing out through the same connection to the boiler, especially when a mud-drum is used, into which it is expected and supposed that the particles of sediment will be gathered. The true thing to be done is simply to wash out the boiler while under pressure, and at work, in the same way and by the same means as would be used if the whole were at a standstill and open, so that a hose and an open jet of water could be used. That is to say, the blowing-down at regular intervals and the corresponding feeding, with the resulting tendency to a complete sweeping of the surfaces, afford a means, of definite and high value, of keeping a boiler clean, if persistently and skillfully practiced.

If in addition to this well-directed effort in the case of any first-class boiler the additional safeguard be present of a construction promoting this constant sweeping of the heated surfaces, a means is secured of the very highest value of increasing both the efficiency and the durability of the whole. The drop-tube, which has been su gested as a detail of great value in this study of a high-pressure boiler-structure, has a very clearly marked and conclusive record, as tending to prevent the fixing on the heated surface of incrusting particles. The sharp circulation within the tube, directed so persistently against the lower or exposed end, appears under very trying conditions of practice to ensure completely the maintenance of the surfaces in the most perfect and unobstructed condition. In fact, nstances are on record in which the incrusting salts, and other sedimentary matter, have been persistently thrown out of these tubes, and over into the water-legs, in marine boilers, to such an extent as to cause injury to the plates in these legs while the tubes themselves have remained perfectly free and clean.

The impression is not well founded that a much higher degree of skill is needed in the attendants who are placed in charge of compound engines and high-pressure boilers. Hundreds of locomotives can be found in which the carrying in ordinary work of 150 to 160 pounds pressure is an every-day occurrence, and in which there is developed, at speeds which are not excessive, fully 750 to 800 horse power. The locomotive-men who manage these engines and boilers would not claim for themselves, as a class, either that they are persons of extraordinary skill or that, on the whole, they would be either unable or unwilling to take charge of any other type of engine of equal or greater power. In other words there are the best reasons for believing that with the highest grades of steam-machinery, referred to in this paper, no difficulty will ever be encountered through lack of attendants. The possession of ready wit and reasonable faculties only is required, such as can be found any day by the prudent selection which is exercised in the choice of men in other kinds of business, involving the care of interests of equal importance.

This brief study is thus submitted to the Institute as an effort to combine in a practicable and workmanlike manner a series of details of engine and high pressure boiler which are neither new, untried, nor inexpedient. The call for improvement in prime movers has never been more pronounced than at the present moment, and the lagging steps of actual advance in steam-engineering appear likely to be spurred onward only by such departures as are here suggested and urged.

DISCUSSION.

Prof. R. H. Thurston, Hoboken, N. J.: The directions of change pointed out in this paper are those that have undoubtedly been pursued for many years. In fact, from the time of Watt, the tendency has been toward a higher pressure, the use of higher piston-speeds, the more complete covering of cylinders and devices to prevent loss of heat and effect, and to secure thorough utilization of the heat supplied to the engine. But progress has been hampered from the beginning by limitations which have not always been recognized, even by engineers. To-day, however, the limitations of economical working of the steam-engine are tolerably well understood. In the direction of higher pressure we have been hindered by the difficulty of obtaining a boiler that would work satisfactorily and safely at these high pressures, and the change suggested by Mr. Barnes has been one that has been sought by engineers from the day steam engines were first invented. It was attempted certainly as long ago as 1804, by old Colonel John Stevens, who obtained in 1805 a patent for one of these forms of boilers. That boiler was built, and a section of it is preserved at the Stevens Institute. It was a lantern-shaped boiler. A fire was built in the interior, and circulated among the tubes. But in all such forms of boiler, difficulties have arisen in the endeavor to secure at once safety, convenience and economy of operation; and among these difficulties I do not know anything that has proved more serious than that of securing dry steam from boilers that shall be so constructed as to be safe against explosion. The principle involved in any boilers made with reference to safety consists in confining the water in small chambers, the explosion of any one of which will not be likely to do serious damage. But in the endeavor to do this it is found extremely difficult to secure a good circulation, and especially to secure a means of separating the water from the steam at the point where it is liberated.

Some of the boilers now in use, and as safety boilers certainly beyond criticism, are still found to present very great difficulties in operation, because of this lack of provision for the separation of the steam from the water at the point where both are liberated from the circulating steam. Where that provision can be introduced, as Mr. Barnes has proposed, it removes one of the great difficulties. We must find means of confining the water in small sections, and Dr. Albans, forty years ago, and Jacob Perkins before him, used steam experimentally of 1000 or 1500 pound pressure to the square inch, and habitually 100 and 200 pounds in just such boilers, and their practice resulted in the production of a combination of steam boiler and engine which gave economies quite equal to engines and boilers of similar power to-day. The limit as to pressure has gradually been elevated from seven pounds in the time of Watt until now we are carrying 150 and sometimes 200 and 250 pounds on river-boat engines. In the sectional form of boiler, so-called, pressures have been carried in regular work, by Perkin's Sons as high as 300 or 400 pounds to the square inch. There seems no reason to doubt that we can get higher pressures if we find it advisable to do so. The difficulty of securing an ample separating surface can probably be overcome by allowing the separation to occur in a larger chamber, but this should be done at points where the flames may not strike the heating surface. In some of our modern safety-boilers all the heating-surface which is near the point of highest temperature is composed of tubes, and the steam is delivered to larger reservoirs where the separation can go on, so that the steam supplied to the engine may be found there fairly dry. The adoption of these forms of boiler will evidently remove all difficulty in the direction of the economical generation of steam; and we then come to the securing of economy in the engine itself. There the direction in which to work is obvious, and our success in that direction is still limited. We find that the engine demands as high a pressure as we can give it, and the steam should be expanded down to the minimum pressure, which should be the sum of the necessary back-pressure of the engine and its own friction; but this ratio of expansion, which would often be something like 25, and sometimes 50, is found to give less economy than where the expansion is restricted to one-half the minimum figure or less. The restriction of the expansion to such a point that the terminal pressure shall be 8 or 10 pounds to the square inch is found on the whole to be more economical practice. As we increase the expansion we must have more expensive machinery. There are certain causes of loss within the engine, such as condensation and leakage. The first is restricted by the use of very dry or superheated steam, which then being steam-gas, is not a good conductor, and does not receive or give up heat as readily as ordinary steam, and so this condensation becomes very much reduced.

Another method of securing economy, which has been adopted in all cases of considerable expansion from the time of Watt has been the use of the "steam-jacket," clothing the cylinder with a warm casing, and thus preventing the metal of the cylinder from losing temperature. By that expedient, in some cases, this internal loss is very greatly reduced,—so much so that to-day the most efficient engines reported are those few pumping engines which have been supplied with high-pressure steam and fitted with steam jackets, and in which the steam is also moderately superheated. The best figures given so far have been about 16 pounds of steam per horse-power per hour. That amount with such engines is about 150 per cent. of what theory would indicate as the limit to which we should approximate, so that even in such engines the loss of heat and steam is 50 per cent. at least, and that represents the margin still remaining to be overcome; and the only way, apparently, to do this in practice is to find some way to secure an internal non-conducting surface for the engines. Experiments have been made by Mr. Emery, and years ago by Watt and Smeaton and others, but they have not resulted in anything of practical value.

These, in brief, seem to be the difficulties in the way of further improvement in the economy of the steam-engine. As we can see, the introduction of a form of boiler that shall be at once safe and economical is one of the essential steps. The other steps must be taken at the engine itself, and by such means as I have indicated the consumption of steam in the class of engines mentioned has been brought down from about 30 to 40 pounds of feed water per horse-power per hour to somewhere from 15 to 18, but more usually 20.

William Kent, New York city: One point made in the paper is the great waste of fuel in metallurgical works. From my own experience I am convinced that economy of steam in metallurgical works is not to be gained so much by inventing improved boilers or engines as by adopting the good boilers and engines already in existence. I have in mind an engine in an iron-works, which has been running for twenty-five years. A diagram from it was sent to an expert in indicator-diagrams, who was asked to figure the saving that might be made substituting for it a better engine. He reported that it would be anywhere from one to three thousand dollars a year, showing that the engine had lost from twenty-five to seventy-five thousand dollars during its lifetime—and the engine is still running. This was three years ago. That kind of work is repeatedly found in iron and steel works of the older kind.

As to this particular boiler that has been presented to us, it looks very much like the Wiegand boiler, which was exhibited at the Centennial Exhibition in 1876, and which has proved practically a failure, especially where bad water is used. I know of one battery of these boilers that was in use in an iron works about six years, and then thrown out and replaced by old-fashioned two-flue boilers on account of the great trouble given by this boiler in keeping it in order. It seems to me the same objection will hold in regard to Mr. Stirling's boiler, and I predict its failure with bad waters.

The author of the paper says the tendency of boiler-engineering at present is to avoid all boilers that are unstayed. I think the tendency is the other way. A stayed boiler is used on locomotives, because we cannot help it. We are restricted to certain shapes. But for boilers on land the avoiding of stayed surfaces is always desirable.

One of the causes of the failure of the Wiegand boiler was that the Field tubes, one tube inside the other, leaving such a small space for the circulation, filled up with scale, and that will happen with the boiler described in the paper, wherever there is bad water. But in New England, where there is good water, it might possibly have a long life.

As regards economy of fuel, the same economy can be reached in this boiler that is reached in a dozen other different kinds of boilers. There is nothing to be gained by this boiler in the way of economy. There is a good deal to be lost in the necessity for repairs and difficulties of cleaning, and there is a great deal to be lost, in case the crown-sheet should get scale on it, and the boiler should on that account explode.

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Ceilings and Floors in Cement Beton.

The *Centralblatt der Bauverwaltung* describes a method of making ceilings with cement beton used in Germany as follows: The frame of ceiling and floor is made of iron I-beams spaced about two feet between centers. To the bottom of these beams is fastened a floor of planks and upon this is poured cement-beton enclosing the beams; the cement-beton is covered with a thin bed of a slag-beton and then a covering of asphalte. This system of construction presents no economy over the ordinary system of springing brick arches from the iron beams and covering with beton; but it is advantageous in not requiring skilled labor, and in rapidity of execution. The floor so made is incombustible and is very solid.

In a school building now under construction at Mayence, the architect has introduced a system which avoids the scaffolding and reduces to a considerable extent the cost of labor. He places under the I-beams, longitudinally with them, small square wooden beams which hold up the plank floor used in laying the beton. These timbers are hung to the iron-beams by screw-clamps, like those used by carpenters, or by a U-clamp passing over the iron-beam and secured under the wooden beams by keys. The planks used as a platform are from 4½ to 5 feet long. The interstices between the planks are covered with strips of roofing felt before the beton is put in place, the latter being well rammed against the iron beams so as to leave no voids.

In this Mayence building, the I-beams were about 4¾ inches (0.12 m) high; the bed of beton was 6 inches (0.15 m) thick and made of one part of cement, one-fourth part lime and six parts of gravel. The gravel itself was composed of one part of well washed Rhine gravel and two parts of sharp Rhine sand. Upon this beton base which covered the tops of the I-beams was spread a bed of two inches of cinder beton, made of one part of lime to three parts of cinders. This second bed after being well rammed was finally covered with $\frac{1}{16}$ inches of cement and about $\frac{6}{16}$ inches of asphalte.

After a comparatively short time the platform planks were removed, and the holes left after the withdrawal of the clamps were filled with first class cement.

The London Inventions Exhibition.

Among the many objects of interest to engineers at the Inventions Exhibition in London are the following:

The Macleod Patent Solid Asphalte and Granitic Pavement. This is claimed to be a non-slippery asphalte roadway; in it the rock asphalte surface is solid with and inseparable from the foundation under it; and to prevent slipping, stone or other material is firmly imbedded in the foundaton and passes through the asphalte, giving a slightly irregular and alternating materials on the surface The foundation instead of being of concrete is a bituminous compound, that will make a good wearing surface even when the asphalte has been worn through. The inventor claims rapidity of execution and great endurance to traffic.

The "Premier" System of Wood-block Flooring. This is a wood-block bedded in a special adhesive compound, said be a preservative against rot and dampness, and this compositio n is forced into V shaped grooves in the sides of the blocks keying them together. Each block is in addition firmly secured to the composition and underlying cement by metal keys, Solidity, durability and warmth is claimed, without the usual space under the flooring for any accumulation of foul air or vermin. Messrs. Geary & Walker, No. 7 John Dalton St., Manchester, are the agents.

The Metric System in Germany.

The Editor of the *Moniteur Industriel*, in the number of May 7, protests against the awkward nomenclature of the metric system as adopted in Germany.

According to the *Moniteur*, the following are some of the points connected with its adoption in the German Empire: The law which defines the system and determines the names of the various units and their derivatives bears date August 7, 1868. The 21st Section declares that the metric system of weights and measures shall become obligatory by law on Jan. 1, 1872, over the entire German confederation. The 22nd Section declares that the system shall be legally optional after Jan. 1, 1870, with the reservation that it should be accepted in any transaction by both contracting parties.

The editor of the *Moniteur* does not know whether the names given below were due to a fear that French terms would wound the Germanic *amour-propre*, or whether they arose from an appreciation of the difficulties attending a total change of form and tongue in a general population; but he does say that in this same ordinance, by the side of the known French terms, used but Germanized for a long time over the whole country, stand the following names:

For the "Meter," *stab.*
"Centimeter," *neuzoll.*
"Millimeter," *strich.*
"Decameter," *kette.*
"Liter," *kanne.*
"½ liter," *choppen.*
"Hectoliter," *fass.*
"½ hectoliter," *scheffel.*
"decagramm," *neuloth.*
"½ kilogramm," *pfund.*
"50 kilogramm," *centner.*
"100 kilogramm," *tonne.*

With a number of others as euphonious as remarkable for their connection with ancient measures.

A certain Mr. Uppenborn excites the ire of the *Moniteur* by denying, in the *Central blatt*, that any such German nomenclature as given above has existence; and the Frenchman points out the fact, that they are to be found in many German publications giving official lists of weights and measures in different countries. Among these publications he cites an Aide-Memoire, of 1875, an *Ingenieur Kalender*, of 1878, and in a *Kalender für Electrotecknike*r, for 1884.

Instead of the m^2 for square metre and cm^3, for cubic centimetre, etc., as fixed by the International Congress of 1884, the German indicates surface measure by a *q* and the cube by a *c*, placed *before* the abbreviation; or precedes the unit by the appropriate adjective, as *quadrat meter*, or *cubik centimeter*.

The *Moniteur*, very justly if its information is correct, regards such notation as *q m* and *c c m* as very confusing to persons to whom the German system is not familiar.

Engineering Societies in the United States.

Since publishing our list of last week, the following additional names have been sent in:

Rensselaer Society of Civil Engineers, Troy, N. Y.

Surveyors Association of West New Jersey, Haddonfield, N. J.

Essayon's Club, Willetts Point, New York.

American Water Works Association, Hannibal, Mo.

Our previous list should be corrected to read:

Engineers' Club of Philadelphia, Philadelphia, Pa.

Michigan Association of Surveyors and Civil Engineers, Lansing, Mich.

As soon as all the returns are in we will republish a corrected list, with the address and names of the Secretaries of the various Associations.

Metallic Railroad Ties in Germany and other Countries.

Les Annales des travaux Publics, for May, contains an article on the development of metallic railroad ties in Germany and other countries, from which the following extracts are taken:

One-eighth of the entire German system is laid with metallic ties, and it is estimated that one-half of all new lines are established with a superstructure of this nature. The engineers of the railways of Belgium, have concluded to adopt the metallic sleeper after a careful study of the subject. But in this latter country, the bad principle is laid down of valuing an iron tie at the same price as a wooden tie, with the result that the metal is inferior in quality and too light in section.

The true economy results from the longer life of the metallic tie and the value, as old metal, of the tie worn out in service. Taking fourteen years as the mean life of wooden ties, and comparing the cost of the wood at the end of that time with the expense of a steel tie at the same period, we find after fourteen years that the wood has cost 12.6 francs, and is worth only one-half a franc; while the steel has cost 14 francs, but still has a value of 3.5 francs. This gives 1.6 francs in favor of the metallic tie, counting the weight of the tie and its accessories at 50 kilos (110 lbs.)

If we take the steel tie at 75 kilos. (165 lbs.) and admit that its lifetime is double that of wood, the advantage is still greater for the steel tie. After 28 years of service, the net expense is 36.8 francs for wood, and 33.9 francs for the steel. If 1 franc is added for repairs and renewals, the economy for the metal ties is 3.9 francs each.

As steel costs from 30 to 40 francs per ton less in Belgium than in Germany, the metallic tie is more economical for the first named country than in Germany.

In the Arlberg tunnel the Heindle system of metallic roadbed is being used over about 10 Kilom.; (6.2 miles), this greatly resembles the well-known Hilf system. The conditions requisite for good results from a metallic tie are, a transverse section resembling a reversed "U," embracing the greatest quantity possible of ballast, so that it may be stable and effectually resist all lateral motion, and the rail should be fixed to the tie in a simple manner, and all fastenings exposed so that any movement in the rails can be at once seen and remedied.

In the Heindle system, the first of these conditions is well filled. The volume of ballast enclosed is about double that held by any other systems of like character, and the bearing surface is increased about one and one-half times. But while this tie offers greater security against sliding, the question arises whether it is possible to tamp the ballast properly in the interior of this tie, with its width of 260 millimetres (10.2 in.) and its height of 100 millemetres (3.93 in.); this is a problem not easy to solve with other ties of like form but of lesser dimensions.

The rail is held to the Heindle tie by vertical bolts and saddle plates, with all the manipulation done from the top of the tie so that a rail can be easily renewed. Between the foot of the rail and the tie is placed a wedge-shaped saddle, which gives the head of the rail the proscribed inclination of 1 in 20; takes up upon its ribs the lateral pressure from the rail and relieves the bolts, and finally prevents direct contact and wear between the rail and tie.

But along with these advantages are the following inconveniences: The saddle employed increases the weight of each tie by 2 or 3 kilos. ($4\frac{4}{10}$ to $6\frac{6}{10}$ lbs.), and as a consequence its price; the pieces required are too numerous and complicate the manufacture and multiply the dangers from misplacement and any loosening tendency. The Heindle cross-tie weighs 72 kilos. ($158\frac{4}{10}$ lbs.), and it costs $1\frac{1}{2}$ times the price of an oak tie, The roadway per running metre weighs 171.73 kilos. while the weight of the ordinary system for the same length is only 130 kilos.

The Rythm of Financial Depressions.

In 1808 there was great commercial distress throughout the United States. In 1837 the banks of New York and other cities suspended payments, and eight States repudiated either the principal or the interest of their obligations. In 1857 there was another great crisis and period of commercial depression. In 1873 the panic came with a suddenness and severity which is still fresh in our memories. Then stagnation existed until 1876, when the curve of prosperity slowly rose upward, and in 1880 a marvellous activity prevailed. In 1884 came another financial depression, and now it is to be hoped that the curve is again beginning to rise and that a long period of healthy business prosperity is before us.

Herbert Spencer has shown that the rythm of motion is a logical consequence of the law of persistence of force. The tide does not rise on the beach continuously, but in a recurring succession of waves. The heat of summer comes not uniformly, but with intermittent periods of warmth and cold. The very wind blows not with continuous intensity, but in rythmic gusts. We see this law of rythm in the diseases which periodically sweep over a country. We see it in the daily fluctuations of stocks, and it is thought that those greater waves whose maxima and minima are the periods of commercial prosperity and commercial depression, but a particular instance of the same law. The present century has witnessed a marvellous growth of material progress, whose general tendency has been to promote business interests and financial enterprises, but like the wave on the sea beach, these interests have now increased and now decreased, as the forces which act upon them have varied in recurring rythm.

As the engineering profession is especially affected by periods of financial depression, it may be well for us to attempt to ascertain the probable length of time from one period to another, as also to give a brief statement of the causes which are supposed to govern their recurrence. The young engineer in particular is one of the first to be thrown out of employment when the panic comes, and it may promote his chances of success to know that the future is not all bright before him, but that dark days and dark years are to be expected.

From 1808 to 1837 was twenty-nine years, and between these dates occurred the war with Great Britain. From 1837 to 1857 was twenty years, and between these dates the war with Mexico was waged. From 1857 to 1873 was sixteen years, and between these dates occurred the civil war. From 1873 to 1884 was eleven years, and no war is included in this period. The average length of time between these critical years is nineteen years. Now if it be supposed that the future is to be like the past, it might be inferred that a commercial depression is to be expected about once in nineteen years. But it is known that war creates a stimulous which greatly modifies business interests, and hence it can scarcely be presumed that the normal period of recurrence is nineteen years. Indeed there are strong reasons for thinking that the natural period is about eleven or twelve years.

The source of all life and activity on this terrestrial ball is the sun. Its rays heat the earth, cause the rain to fall, the wind to blow, and the crops to grow. On the weather depends the health, both physical and mental, of man. On the crops depends the prosperity of nations, for all men must eat and be clothed. Now the astronomers who have watched the sun tell us that there are spots on his photosphere, and that these spots come and go in rythmic periods. The time from one period of sun-spot maxima to the next is between eleven and twelve years. As the number of spots increase, the auroras shine with splendor, earthquakes are heard, tornadoes abound, and the weather and the crops become abnormal. These influences affect the financial interests of the country, and it is thought that they cause a tendency to a period of commercial distress.

But the astronomers have gone further, and allege that the revolution of the mighty planet Jupiter, once in twelve years around the sun, is the primary cause of the dark spots in the solar envelope. For the mass of Jupiter exerts a certain attractive force upon the sun, which undergoes great variations, depending on his relative position with respect to Saturn and the other planets, and these pertubations are thought to be sufficient to disturb the sun's photosphere and cause the spots to come and go.

Regard it then as fairly probable that the rythm of financial depressions is a a consequence of the laws which govern the stars in their courses. The motions of the planets produce pertubations, the pertubations cause the solar storms or spots, these in turn cause variations in the magnetic and thermic rays, which affect the weather upon our earth, and, perhaps, also the minds of men, the weather affects the crops, and the quality and quantity of the crops acts upon the market to depress the curve of commercial prosperity.

There is hence some probability that the normal time from one period of depression to the next is about eleven or twelve years. From 1873 to 1884 was eleven years. The period of maximum sun spots was in 1871 and again in 1882, preceeding a little the crisis of 1873 and 1884. From the first period of distress in 1880 to the last in 1884 is seventy-six years, which is very nearly a multiple of eleven. From the great crisis in 1837 to the one in 1884 is thirty-six years, which is exactly a multiple of twelve. Both theory and observation therefore indicate a tendency to a normal period of eleven or twelve years.

Judging from the past, and from the theory here so briefly set forth, the next period of financial depression may be expected in 1895 or 1896, if no war intervenes. The present wave has not carried us so low as that of 1837, or 1857, or even that of 1873. The upward wave, now slowly beginning to rise, may perhaps not carry us so high as those of 1871 and 1881. But rise it surely will, and fall again it surely will, for the wonderful law of the rythm of motion requires periods of minima as well as of maxima.

"M."

PERSONAL.

THEODORE PASCHKE has been appointed chief engineer of the water-works extension at Guatamala, C. A.

MR. JAMES S. MORRISON has resigned as chief engineer of the Cape Fear & Yadkin Valley road.

G. M. THOMPSON has been appointed chief engineer of the Boston & Lowell R. R. in place of Mr. I. M. Story, resigned.

MR. J. CALDWELL has been appointed superintendent of the Champaign, Havana & Western Railway, with office at Urbana, Ill.

H. P. HARRIS has been appointed General Superintendent of the Pittsburg Division of the Baltimore and Ohio.

G. BOUSCAREN, C. E., having retired from the position of Chief Engineer of the associated companies of the Cincinatti, New Orleans and Texas Pacific Railways, announces that he has opened an office as Consulting Engineer, at No. 35 W. Fourth St., Cincinnati, O.

MR. JOHN SCOTT, general manager of the Cincinnati, New Orleans & Texas Pacific Railroad Company, has resigned, to take effect June 1. His successor has not yet been designated. Mr. Scott has been in Cincinnati since 1881. When the Cincinnati Southern Railroad was leased, he was made its general manager. He had previously been general manager of other roads in the South known as the Erlanger system.

PROFESSOR OREN ROOT, LL. D., for many years Professor of Mathematics at Hamilton College, died May 22, at Clinton. Professor Root was born at Vernon, N. Y., eighty-one years ago. He was graduated at Hamilton College, and early in life became a teacher in tha Syracuse Academy, and acted in the same capacity at Seneca Falls. Thirty-five years ago he was elected to the chair of mathematics, mineralogy and geology of Hamilton College, holding the position until about three years ago, when he was succeeded by his son. He was then made Professor emeritus. He was distinguished as a mathematician and for his skill as a mineralogist. One of the best collections of minerals in the State was made by him and is now owned by the college. He was father of the Hon. Elihu Root and Professor Owen Root, of Hamilton College.

W. CHARLES JOHNSON, who had been connected with the stage and railway lines of New York for over 30 years, died at West 22nd St., May 19. He was born in Hallowell, Maine, 1814, and in 1843 married and removed to Boston. He came to New York in 1850, and in 1851 became one of the owners of the famous old Knickerbocker line, which went out of existence when the Bleecker Street

Railroad was started. Later he became connected with the 23rd St. Stage Line. In 1860 he became one of the owners of the Red Bird Stage Line running from Grand St. Ferry to 42nd St., afterwards merged in the street car line between these points. He was one of the originators in 1863 of the Broadway and 7th Ave. Railroad; and also organized and was president of the Vesey St. and South Ferry street car line: he left both these companies about four years ago.

American Institute of Electrical Engineers.

The general meeting of the American Institute of Electrical Engineers was held May 20 at the house of the American Society of Civil Engineers, at No. 127 East Twenty-third street. The first paper was on "The Protection Inventions," by Mr. Frankland Jannus, of Washington. In the course of the discussion which followed it was stated that there was no chemical or electrical laboratory in the Patent Office. A resolution to the effect that a committee be appointed to call the attention of Congress to the needs of the Patent Office, especially in regard to the class of electricity, was referred to the council for action.

A paper on "The Cost of Mine Lightning," by Mr. F. P. Mills, was read by the Secretary. Mr. Edward P. Thompson read a paper on "The Electric Arc Lamp Frictional Clutch." and described at length a clutch in the shape of a spiral spring, the use of which he claimed would produce good results in the way of steadiness of light and regularity of feeding the carbon. Mr. Jannus, of Washington, presided at the afternoon session- Mr. E. P. Roberts, of Cheyenne, Wyoming, read a paper. His company at Cheyenne was the first to introduce storage batteries and incandescent lighting in connection with the arc light system. The result of his experience of two years is that storage batteries have been both praised and belittled too much; that the service can be made good, but that it is not preferable to dynamos in closely settled districts.

A summary of a paper by Prof. E. J. Houston on "The Delany System of Fac Simile Telegraphy," presented by Mr. Frank L. Pope electrician of the Bell Telephone Company, closed the proceedings.

Asphalt vs; Wood Pavements.

Concluded from page 330.

After the reading of his paper, M. Malo, in answer to questions, made some further remarks upon roadways of *asphalte comprimé* and wood.

According to the new schedule of charges in Paris, the price of *asphalte comprimé* is as follows:

Bed of Val-de-Travers or Seyssel asphalte, compressed to a thickness of 0.05 m (2 in.) per superficial metre 10.76 sq. ft.)	14 francs
Beton of Portland Cement, 0.15 m (6 in.) thick, per superficial metre	5.40 "
Total	= 19.40 francs

As an exception to the general rule the *rue de Richelieu* has been laid within the last eighteen months, with heavier beds to compensate for the excessive traffic, as follows:

Asphalte, 0.06 m (2 ½ in.), per superficial metre	16 francs
Beton, 0.20 m (7 9-10 in.), per superficial metre	7 "
Total	= 23 francs

The price of asphalte pavement in Berlin is practically the same as in Paris, being as follows:

Asphalte (Val-de-Travers, Seyssel or Sicily,) compressed to a thickness of 2 in., per superficial metre	13.75 francs
Beton of cement, 7 9-10 in. thick, per superficial metre	5.62 "
Total	19.37 francs

The wood pavement of Paris, as recently laid, is placed upon a bed of Portland cement beton, 0.15 m (6 in.) thick, with the blocks soaked (not injected) in creosote, and with the fibres of the wood vertical. A superficial meter of this paving costs 23 francs. The annual cost of repair to the roadways of Paris is: for *asphalte comprimé* 2 francs, and for wood pavement (according to the style) from 2.60 to 2.95 francs per superficial metre.

The final acceptance of work in asphalte is in the month of May, of the year following that in which the work was done; and no repairs are paid for until the month of January following that. Wood pavement is accepted at the end of the year of execution. This wood pavement is paid by an annuity at the rate of 2.42 francs per superficial metre per year, for 18 years.

In answer to further questions M. Malo said that asphalte is a calcareous rock, which is found in certain localities, but rare enough in general. This rock is nothing more than a perfectly pure carbonate of lime, naturally impregnated with bitumen. The authorities disagree as to the manner in which this bitumen got into the rock; some say it penetrated in a liquid state, others that the bitumen was originally in a state of vapor.

The beds of this calcareous rock are naturally solid and homogeneous, but everywhere where it has been impregnated with the bitumen it has ceased to be solid or homogeneous. For if we take a morsel of this bitumenized rock and heat it, it will fall into a powder; and if we examine this with a microscope, we will see that it is composed of very fine grains of a white calcareous rock each covered with a very thin coating of bitumen, by means of which each grain is cemented to its neighbor. It is upon this very singular property of asphalte that the system of roadmaking with *asphalte comprimé* is founded. It is not as if the calcareous rock was impregnated with bitumen as a body is filled with oil: for if we took a piece of plaster and soaked it in oil, and then removed this oil by any means required, the plaster would remain as solid as before; but if we take the bitumen away from asphalte there only remains the powder of a carbonate of lime.

Originally the asphalte was mined for the manufacture of illuminating gas. The wagons used in transporting the mineral dropped morsels of their load on the road, and these fragments, heating and slacking into powder under the action of the sun, were compressed by the wheels, and ended in making an *asphalte comprimé*. About all the asphalte mines these natural roadways abound.

The principal of the system being thus discovered, the next thing was to practically apply it in the construction of streets in our cities. The users commenced by grinding the rock cold and thus reducing it to a fine powder; then warming it and spreading it over the roadway, and compressing it with rammers and rollers. But as a high temperature was required to bring about the renewed cohesion of the particles, and as this powder, at a temperature of 120° to 130° *C*, was spread upon a bed of beton, usually still damp, it happened that the humidity in the beton was vaporized, and this vapor penetrating the covering of asphalte cut it up and disintegrated it, giving rise to the cracks and deteriorations which were so frequent in the original application of this system.

The only disadvantage of an asphalte roadway is that it is, under certain conditions, slippery under the feet of horses. While this is incontestible, it is only true, just when a fine rain commences to fall; when the asphalte is dry, or even damp, slipping is rare.

At the meeting of the *Société des Ingénieurs Civils*, in Paris, March 6th, M. Molinos made some remarks upon the paper of M. Malo read at the preceeding meeting, (see ENGINEERING NEWS, May 23) practically as follows:

While he agreed almost entirely with M. Malo in his general observations, he differed somewhat with him upon the question of wood-paving, of which he thought M. Malo knew less than about asphalte.

M. Molinos did not believe with M. Malo that wood pavement was destined to disappear in Paris. Aside from the mere requirements of comfort in riding, there was another consideration, and that was the almost insupportable noise arising from the increasing traffic on sonorous pavements. In some of the narrow streets it is impossible to live with the windows open.

M. Molinos was convinced that the future belonged to the paving which would unite to the advantage of a smooth roadway, as asphalte and wood, the other advantage of suppressing noise. From the last stand-point wood paving best solves the problem, and in the narrow streets with a large circulation asphalte will incommode the neighborhood by noise, more than wood.

M. Molinos would not admit the allegation that wood-blocks soaked in creosote, as practised in Paris, had a tendency to rot; experience showed the contrary, He had himself taken up blocks in London, eight years in use, which were as sound as on the first day laid. He believed in the efficacy of the steeping process, and he exhibited sections of blocks showing a sufficient penetration of the fluid to preserve the wood perfectly.

As to the final condemnation of wood pavement in Berlin, as stated by M. Malo, he thought it was with wood there, as it was originally with asphalte. It was laid without judgement by men without experience, and hence badly done. Wood pavements have failed at times everywhere, but the Kerr system, as used now in London and Paris, is destined to spread rapidly.

As to cost, wood pavement is not more expensive than asphalte. It has been practically demonstrated that a 6 inch foundation of beton and a 6 inch wood block meets all the requirements of heavy travel, and this will cost 23 francs per superficial metre; while the cost of the asphalte pavement as given for the *rue de Richelieu*, should be taken as the type of a good asphalte roadway, which costs the same price. As to the repairs, the cost for wood is 2.95 francs per square metre, per annum; but what an asphalte pavement, subjected to like circulation, would cost, is a thing yet to be determined. He thought wood pavement should be replaced every 6, 7 or 8 years, according to the amount of traffic.

At the session of April 10th., of the *Société des Ingénieurs Civils*, M. Leon Malo replied to the above given remarks of M. Molinos, substantially as follows:

M. Molinos commences by declaring that asphalte is more noisy than a wood-pavement. I concede that it is not less noisy, and that a horse has better footing upon wood than upon asphalte, in cold weather; but the difference between the two in the matter of noise is slight, in summer especially when the asphalte softens slightly, and if the residents on an asphalte-paved street are compelled to close their windows owing to the clatter, I can only say that their sense of hearing must be exceptionally accute.

On a stone pavement it is not the hoofs of the horses that cause the intolerable din, but it is the rolling and jolting of the carriage wheels; and upon this score M. Molinos must admit that there is little difference between asphalte and wood. On the other hand, if a partial suppression of noise is desirable to the residents on a street, its absolute suppression is dangerous to the foot passenger, the clatter of the horses' hoof is necessary to warn the passer-by if the noise of the wheels is to be entirely removed.

M. Malo does not agree with M. Molinos on the immunity of wood pavement from decay; without referring to disastrous experiences in

London, Washington and Berlin, where wood pavement had been taken up and replaced by asphalte, he affirmed that the pine-wood used in these pavements is always more or les damp, and as a consequence more or less exposed to rot. He asked M. Molinos to visit certain streets in Paris, where the wood and asphalte pavements joined and were of the same age, just after a rain; he would find that the asphalte was completely dry within two hours after the shower, while the wood pavement would remain damp for two or three days thereafter. M. Molinos would have to admit that the water, which can not penetrate the asphalte, must have deeply impregnated the spongy pine-wood and introduced elements more or less productive of decomposition.

The eventual decay of a wood pavement did not concern M. Malo as much as the deterioration that this rotting caused in the roadway; accidents can be prevented by sufficient repairs; but it is after all a simple question of repairs. But he did especially fear the absorption, indefinitely repeated, of the atmospheric humidity or rain by the woody fibers, and the effect of this absorption upon the public health. It was the permanent impregnation, by the liquid filth of the streets, of this immense sponge, and the expiration of this foul matter in the shape of miasma under the influence of the sun's rays that he most dreaded. It is for this reason that he recommends the use of wood for wide and well ventilated streets and its rigid exclusion from the narrow ways.

As to the slippery nature of the asphalte under a horses hoof, M. Malo admitted that during the period of a fine rain falling upon the fine dust of a street, the asphalte would be inferior to wood. But this was only during an average of 15 or 20 days in a year. Asphalte, like wood, is not perfect; but when asphalte is dry or only damp he believed it was no more slippery than wood. In London, with its fogs, it was probable that the objection to asphalte might be more serious than in Paris.

CORRESPONDENCE.

Thick vs: Thin Courses.

ELMIRA, N. Y., May 22, 1885.

EDITOR ENGINEERING NEWS.—There is a wager pending on the question of the strength and durability of the following class of stone masonry which we respectfully refer to you for decision. J. D. holds that a two and one-half foot wall, laid against a rock or clay wall for an arch, is more durable by being laid in cement. Stones with flat beds, thickness to be from 4 inches to one foot in broken ashlar; the wall in height is about fifteen feet, and the space of arch 28 feet.

D. C. H. holds that a wall as described is stronger and more durable when laid in courses, averaging in thickness from one to two feet, all supporting the span of arch.

Please reply through your valuable paper to

"IAGO."

[Your wall is very thin for the height, being simply a facing wall; the only danger to be apprehended from very high courses is from any divergence of the line of load from the vertical, causing a buckling action on the face. But with courses not more than 2 feet high, with properly cut beds and good mortar, we would prefer the coursed work to the broken ashlar, as having a minimum of the material that is liable to be bad, or to be carelessly applied; that is, the mortar. With good stone and first-class cement, properly used, the broken ashlar work would also undoubtedly meet all the requirements of the case as far as we can see them. [ED. ENG. NEWS.]

Iron in Architecture.

E. VIOLLET LE DUC.

Men may say that iron can never be employed in our buildings in an outwardly evident manner because it does not lend itself to monumental forms; but it would be more in accordance with truth to say that existing monumental forms, being the consequences of the employment of materials possessing totally different qualities from those of iron, cannot be adapted to the latter material. The logical deduction is that we must not restrict ourselves to those forms, but must devise others appropriate to iron.

Board of Public Works, Chicago, Ill.

The report of the Commissioner of Public Works Chicago, for the year ending Dec. 31, 1884, was issued May 16.

About twenty-five miles of water-pipe were laid during the year, making a total of over 543 miles now in use. The water supply for the year was 29,286,000,000 gallons, a daily average of over 80,000,000 gallons. Nineteen miles of brick and pipe sewers were laid during the year making a total in use of 414 miles. Thirty-four miles of roadway were paved during the year, making a total of 224 miles of paved streets in the city. Twenty-eight miles of new sidewalks were constructed, making a total of 804 miles now in use. An aggregate of 2,225 miles of streets were cleaned during the year. The aprons, crossings, culverts, etc., built numbered 4,817, and 1,703 street-lamps were erected. The buildings moved numbered 726. The maps and plats made aggregated 1,610. The special assessments prepared numbered 468. The miscellaneous work included the Rush street bridge, iron viaducts at West Twelfth street, Centre avenue, Chicago avenue and Halsted street, the completion of the new City Hall, and the dredging of the river. The total number of contracts for the year was 341, and their aggregated cost was $2,589,138. The total amount of money at the disposal of the department was $7,275,116; of this amount $2,206,046 had been expended from the general appropriation of 1884, and $4,009,949 from the water fund, leaving a balance of $1,059,120 to the credit of the department. The water-works receipts for the year were $1,288,941, and the expenditures $1,152,044, leaving a credit balance of $136,897. The total cost of the water system of the city from its inception up to Dec. 31, 1884, was $10,099,658; the total revenue for the same period was $15,530,071; the total operating expenses, including maintenance interest on debt, etc., for the same period was $11,878,555; making the total surplus revenue over total expenditures $3,651,516. Of this surplus there is a cash balance in the Treasurer's hands of $797,817. The total interest paid on water loan to Jan. 1, 1885, was $5,407,008. The total of water-loan bonds outstanding is $3,955,000.

THE WATER SUPPLY.

The report says that measures for increasing the pumping capacity cannot longer be deferred without detriment to the city's interest, and recommends the construction of a new independent inlet from the lake, together with new and independent pumping-works.

Regarding the waste of water the report says:

The daily consumption of water in the city during the year averaged nearly 114 gallons per capita. It is no exaggeration to say that quite one-half of this quantity is unnecessarily wasted. This fact is verified in some measure by the following figures: Of the more than 26,000,000,000 gallons of water pumped during the year, about 4,600,000,000 gallons was paid for by measurement, and the balance, 24,400,000,000 gallons was paid for by assessment, amounting to $795,494.48. Had the latter quantity of water been paid for at the minimum meter rates—viz: Eight cents per 1,000 gallons, the revenue would have been $1,952,000 instead of the amount above stated, or nearly two and a half times greater than was received, showing that the revenue received for about five-sixths of the water used in the city is about three and a quarter cents per 1,000 gallons.

It appears that the greatest waste of water occurs during the periods of extreme heat and cold. From January 1st to May 1st—the cold term—there was a gradual daily decrease up to and during the month of April, when the daily consumption fell off 10,000,000 gallons. From May 1st to Oct. 1st—the hot term—the consumption of water rapidly increased up to and during the month of September, when it reached 15,000,000 per day in excess of the quantity pumped in April. In other words, the daily average consumption from Jan. 1th to April 30th was less than 78,000,000 gallons, while same consumption was nearly 81,000,000 from May 1st to Oct 1st.

It is believed that the principal waste of water is due to negligence, as it is hardly probable that such abuse of water privileges can be the result of willful intention on the part of any person, as such abuse is violation of city ordinances, and amounts, in addition, to an utter disregard of the rights and privileges of neighbors.

One of the most prominent sources of waste is water-closets generally, but especially those which are placed under side walks and other exposed places. During cold weather they are allowed to run almost continually to prevent freezing, and at all times they are liable to become filthy for want of proper care.

While the most reliable and efficient means of preventing waste and bringing the consumption of water within reasonable limits is a resort to a general use of meters yet it is believed that a rigid and adequate house to house inspection, properly carried out, would go far to remedy the evil; such an inspection, however, may and should comprehend more than a mere waste of water. It should combine a thorough and systematic annual examination of the plumbing generally, including the extent and character of house drainage, the essential ally of a water supply. Inspection of every house, public or private, by competent officers would determine whether or not a premises were in a proper sanitary condition so far as relates to water supply and drainage, and a certificate should issue accordingly. Such inspection is quite as essential to the protection of the inmates as an inspection and certification of the condition of a steam boiler: for, in the opinion of the writer, there is far more danger to life and health lurking in a long-continued, defective, and inadequate system of house plumbing than exists in any well-managed steam-boiler, the frequent inspection of which is required by law.

It is intended to inaugurate at an early day a system of inspection as above suggested.

SEWERAGE.

The year's expenditures on sewers and catch-basins was $258,020, of which sum $186,653 had been spent in the West Division. The bonded sewer debt outstanding aggregates $2,622,600. The total interest paid on sewerage bonds to Jan. 1, 1885, aggregated $4,106,676; the total interest on river improvement bonds, $3,030,940; and the grand total of interest paid altogether on water, sewerage, and river bonds $12,544,624. The operating expenses of the pumping-works for the year were $32,587. The south Branch pumping-works are stated to have been of no effect on the South Fork of the river, and consequently that stream is exceedingly filthy. This, the report says, should be speedily remedied. The Ogden Ditch nuisance is then referred to, and the reconstruction of the dam recommended.

OTHER MATTERS.

The total cost of repairing bridges and viaducts for the year was $60,368. The Rush street bridge cost $138,019, the Chicago avenue and Halsted street viaduct $149,637 (besides $135,696 paid by the Northwestern Railroad), the Central avenue viaduct $105,062, exclusive of railroad payments, and the Twelfth street viaduct $7,554. The total cost of work on bridges and viaducts for the year was $607,945, of which sum the city paid $400,275 and the railroad companies $207,670. The Erie street viaduct, to be completed about May 15, will cost $45,000. The year's expenditure on the thirteen parks under the jurisdiction of the department was $12,762. These parks aggregate eighty-two acres, the largest being Lake Park, with forty-one acres. Larger appropriations are asked for park improvements. The year's expenditure on the new city building was $246,105, making a total expenditure on the building of $1,469,973. The total cost of the building when complete will be $1,642,038.—Chicago *Tribune*.

The Armies and Navies of Europe.

The following tabular statement shows the population of each European nation, its standing army and reserves, and war ships (ironclads and armored) in commission:

NATIONALITY.	Population.	Standing army and Reserves.	Ships.	
			Ironclads	Unarmed
Austria	31,786,346	1,026,130	13	43
Belgium	4,172,921	224,814	....	....
Denmark	1,969,039	50,469	8	30
France	37,672,048	3,750,000	56	246
German States	45,234,061	5,670,000	24	53
Gt. Brit. and Ire.	35,026,108	545,385	60	300
Greece	1,979,305	82,076	2	14
Holland	4,172,921	175 000	19	116
Italy	28,459,451	2,785,000	13	70
Luxembourg	209,570	.....	....	....
Montenegro	250,000	21,850	....	....
Norway	1,913,000	40,700	4	33
Portugal	4,160,315	75,000	1	48
Roumania	5,376,000	210,000	1	4
Russia	85,058,415	3,210,000	3	219
Servia	1,820,000	210,000	....	....
Spain	16,061,859	400,000	7	68
Sweden	4,572,245	183,851	14	119
Switzerland	2,846,102	205,176	....	....
Turkey	8,631,369	500,000	20	12
Totals	327,371,077	19,355,461	279	1375

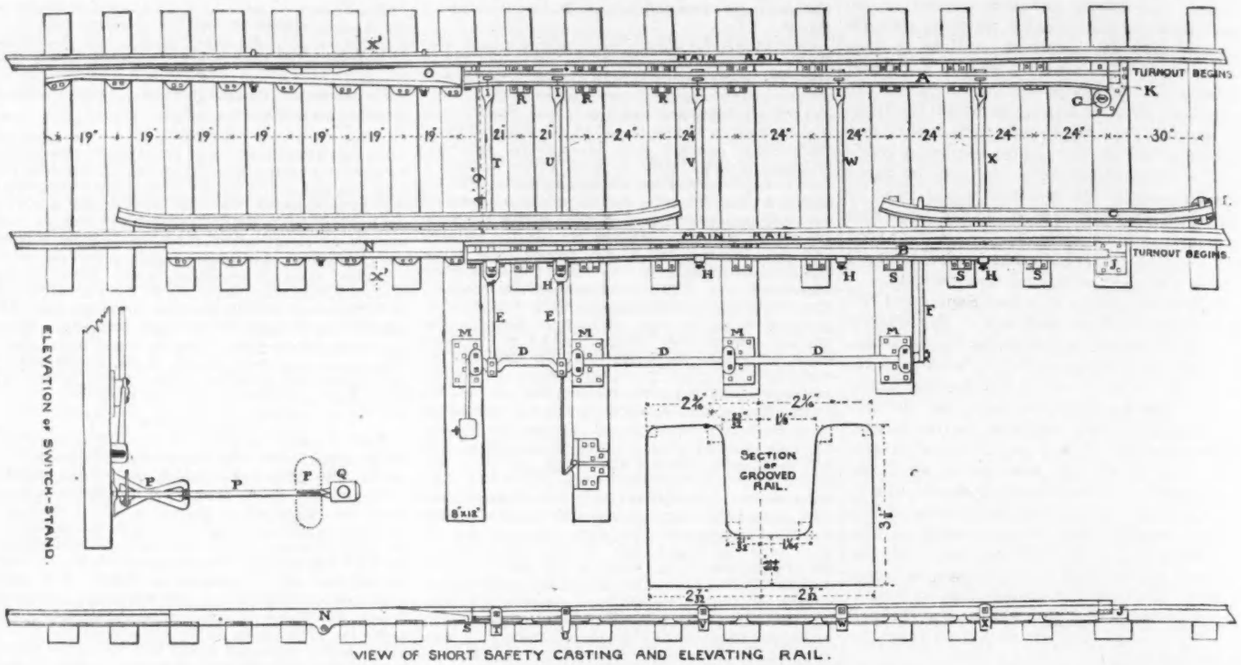
French and English Masons.

CAPTAIN FOWKE, R. E.

There is a very wide difference between the manner of working of an English and French stonemason, for while the former makes use exclusively of his trowel for taking up and laying mortar, using his hand merely in placing and arranging the stone, a French workman takes up a trowel full of mortar in one hand and a handful in the other; and really, to see him at work, the first impression is that his trowel is a mere auxiliary, and that the principle part of the work is done with the other hand. Their work, nevertheless, is remarkably good and firm; part of this, however, may be attributed to the admirable mortar which they employ, and to the ease with which the stone generally used is capable of being brought into any required shape.

FIG. 91—WHARTON SWITCH.

PLAN SHOWING SWITCH OPEN.



VIEW OF SHORT SAFETY CASTING AND ELEVATING RAIL.

TRACK.*

BY W. B. PARSONS, JR., C. E.
ROADMASTER SUSQUEHANNA DIVISION ERIE R. R.

(*Continued from page* 333).

All point switches have one rail in each track continuous. There is however, one switch, the Wharton †, which leaves both main track rails unbroken, the wheel flanges being lifted over. Fig. 91, shows the full working plans. *A*, is a grooved rail, the cross section of which is given, and connected with the elevated rail *B* by five clamps or connecting rods—*T*, *U*, *V*, W, *X*, and in turn the elevated rail is in connection with the crank shaft *D*, through the draw rods *E*. Thus, by turning over the weighted lever the grooved and elevated rails are moved like the points in split switches, No. 2. The elevated or "camel back" rail, is one of the ordinary pattern curved vertically, and resting on a graduated series of iron blocks, so that while its point is level with the top of the main rail it gradually gets higher, and about 8 feet back from the point is 1½ inches above main rail. When the switch is being operated the outside of the wheel treads bear upon the elevated rail and the whole wheel is gradually raised by it. While at the same time the other wheels have entered the groove and are resting on the outside rim of the channel; and when the proper clearance is gained the inside wheel is carried over the top of the main rail, and thus the transfer is made.

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† The following table names the various parts of the Wharton Switch, reference being made to the cut above:

A, Groove Rail, 100 lbs. per yard.
B, Elevating Rail.
C, Moveable Guard Rail.
D, Crank Shaft.
E, Draw Rods.
F, Guard Rail Draw Rod.
G, Groove Rail Clip, Bolt and Nut.
H, Set of ⅞ inch, Bolts for Elevated Rail.
I, Set of ¾ inch Bolts for Groove Rail.
J, Elevating Rail Chair.
K, Groove Rail Chair.
L, Moveable Guard Rail Chair.
M, Crank Shaft Stands.
N, Short Safety Casting, Steel-plated.
O, Long Safety Casting.
P, Stand and Revolving Target.
Q, Target Lantern.
R, *S*, Blocks.
T, *U*, *V*, *W*, *X*, Clamp Rods.

[ED. ENG. NEWS.]

Its automatic working is also simple. When it is set wrong against the main track the moveable guard rail *C*, is brought in close contact with the main rail, for one end of this little rail is firmly held by the chair *L* and the other is free to be controlled by the crank shaft through the means of draw rod *F*. When thus set wrong the first pair of wheels entering between the guard rail and the main rail throws the former ou ,which motion is immediately transmitted to the crank shaft, the

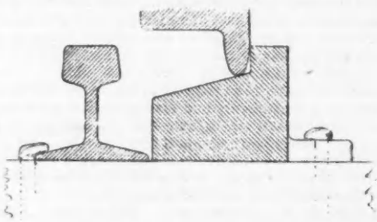

FIG. 92a. CROSS-SECTION, WHARTON SAFETY CASTINGS.

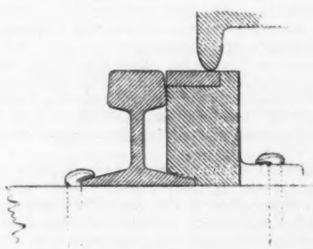

FIG. 92b.

weighted lever is thrown over and the switch is moved as if by hand. If left wrong for the side track (as shown in the figure) the switch is not moved but the wheels when they reach the end of the elevated and grooved rails drop on their flanges upon the two safety castings *N* and *O*, cross sections of which taken at *X' X'* are given in Fig. 92. The rib of casting. *O* serves as a guard rail while at the same time the opposite wheels run over the top of *N* and the adjoining rail and drop into place.

The great advantages of the Wharton switch are the unbroken main rails and the fact that the apparatus when not in use is entirely out of the way and not subject to wear. Against it is urged its cumbersomeness and space required. These objections probably prevent its general use in yards where ground has to be economized or at points where it is likely to be subject to fast running. But for way stations or outside switches the Wharton is entirely an admirable device.

In treating the subject of frogs and switches it is impossible, in an article like this, to show every patent, and the aim has been to make clear the general principles their operation and the leading points in their manufacture by giving that selection which will best illustrate the different classes and of those classes present types of recognized merit. The questions of "interlocking" by the different systems with their beautiful and elaborate details belong to a different field.

(*To be Continued.*)

How Gas can be Made for Nothing.

In a recent instructive essay on "Electric Lighting," Mr. Mattieu Williams, F. R. A. S., incidentally alluding to the cost and price of illuminating gas, says:

"I refer more particularly to the practical and crucial question of economy. The by-products, the ammonial salts, the liquid hydro-carbons and their derivatives have been developed into so many useful forms by the achievements of modern chemistry, that these, with the coke, are of sufficient value to cover the whole cost of the manufacture, and leave the gas itself as a volatile residuum costing nothing. It would actually and practically cost nothing, and might be profitably delivered in the burners of the gas consumers (of a far better quality than now supplied in London) at 1 shilling per 1,000 cubic feet, if gas-making were conducted on sound commercial principles—that is, if it were not a corporate monopoly and were subject to the wholesome stimulating influences of free competition and private enterprise." These views are not the vaporings of a scientific crank—they are the averment of facts accomplished, briefly though plainly stated by a scientist, who closely observes and properly weighs the importance of the very many improvements recently developed in the field of artificial illumination. He has but noted an epoch in the history of gas production—the next will be, when it supplants all other kinds of fuel in large towns and cities.

Strength of Timber Beams.

The formulæ given by Tredgold are too abstruse for general purposes. There is, however, one given by Nicholson which is simple and not far from the truth. A number of experiments were made on pieces of various woods, each 1 inch square and a foot long, and weights which broke them recorded. Then as this weight c: is to the length of any given beam in feet l;: so is the weight the beam will have to bear (in lbs.) w; to the breath b multiplied into the square of the depth d of the intended beam; or as $c : l :: w : b \times d^2$. Any of these three being given, the fourth is easily found. The breaking weight of Memel fir he gives as 330, that of oak he gives as 810; but this last seems too much. Suppose there is a ware-house 16 feet wide, the girders of which are 10 feet apart, and each superficial foot is to carry 3 cwt., or 336 lbs. Then as each girder supports $16 \times 10 = 160$ feet superficial, and as eachfoot is to carry 336 lbs. the total weight to be carried is 53,760 lbs., distributed over the whole, or half this, 26,880 lbs., in the center. Then as 330 : 16 :: 26,880 : 1,303, or the breadth multiplied into the square of the depth. But this is breaking weight, and no timber ought to be used of less strength than four times this. Then $1,303 \times 4 = 5,212$, the least amount we ought to reckon upon. Now we have our choice either to assume a breadth or a depth. Suppose we are confined to 17 inches for the latter. Then $\frac{5,212}{17 \times 17} = 18$ inches very nearly. If we assume 15 as our breadth, then $\frac{5,212}{15} = 347$, the square root, which is nearly 19 inches; so that we may have a girder 18 inches wide and 17 inches deep, or one 15 inches wide and 19 inches deep as we please.—*A. Ashpitel.*

Loads on Stone.

It was observed by M. Rondelet in the course of his very numerous experiments that it was not the heaviest stones which offered the greatest degree of resistance to compression, but those of a fine even grain and close texture with a deep color; that of granites, the most compact and perfectly crystallized was the strongest, and that when all other qualities were the same the strength was in proportion to some function of the specific gravity. The pillars of the Gothic church of All Saints at Angers, of Fourneau stone support on each superficialfoot a pressure of 86,000 lbs. The pillars of the dome of the Pantheon at Paris, the lower part of which are of Bagneux stone, support on each superficial foot 60,000 lbs. The pillar in the center of the chapter-house at Elgin, which is of red sandstone, supports on each superficial foot 40,000 lbs. The piers which support the dome of St. Paul's in London sustain a pressure on each superficial foot of 39,000 lbs. The piers which support the dome of St. Peter's at Rome sustain a pressure on each superficial foot of 33,000 lbs. The pressure on the keystone of the bridge at Neuilly has been estimated for each superficial foot at 18,000 lbs. In regard to these examples, we have to remark that the calculators of them have considered the pressures as uniformly distributed over the pressed surface; but this can only be true when the direction of the resultant of the straining force coincides with the axis of the pier or pillar; besides stones cannot be wrought absolutely level, nor bedded in perfect contact.—*A. Ashpitel.*

THE PENETRATION OF LIGHT IN WATER.—Experiments have recently been conducted in the Lake of Geneva and elsewhere by MM. Fol and Sarasin, to determine the depth to which light penetrates in its waters. The method of experimenting was to submerge photographic plates of gelatine-bromide of silver at various depths and develop the luminous images produced on them by rays penetrating from the surface. A coating of bituminous varnish was employed as the developer, and allowed to act for ten minutes. In clear sunlight during March, and near Ville-franche-sur-Mer they obtained images to depths of about 400 metres. The images increased in strength as the depth diminished. In the Lake of Geneva, they, however, only obtained images to a depth of about 200 metres, or half as far; and the authors conclude that in the winter months sunlight does not penetrate further than 200 metres, while in the Mediterranean it stops at about 400 metres deep.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.: M. INST. C. E.

(CONTINUED FROM PAGE 318.)

DCCLI. NEGAUNEE, MICH.

Negaunee, Marquette Co., Michigan, is in lat. 46° 35′ N., long. 87° 30 W. Its chief importance is due to the mining, manufacture and shipment of iron which abounds in that region.

Water-works were built in 1883, by the city, taking the supply from surface water. From a lake the water is pumped by a Worthington steam pump directly into the mains.

Distribution is by 3 miles of Wyckoff wood pipe, with one meter and 20 fire hydrants.

The works have cost $30,000. The bonded debt is $25,000 at 4½ and 5 per cent. The population in 1880 was 3,931.

No further information can be obtained.

A. W. Maitland is superintendent.

DCCLII. NEVADA CITY, CAL.

Nevada City, California, in lat. 39° 20′ N., long. 120°, 40′ W., the County Seat of Nevada Co., is in mountainous country in which little attention is paid to agriculture, the principal industries being gold mining; lumbering and manufacturing.

Water-works were built in 1861 by a private company, taking the supply from the South Yuba River by gravity, giving a pressure of 200 pounds in the mains.

Distribution is by 4 miles of cast-iron pipe of 10 to 4 inches in diameter, with 29 fire hydrants, one meter and 300 taps. Service taps are of wrought-iron. The daily consumption is 680,000 gallons. The city pays $100 yearly for the use of each hydrant.

The works here cost $35,000. There is no bonded debt. The yearly expenses of maintenance are $5,000 and the receipts $11,000. The population in 1880 was 4,022. J. E. Brown is superintendent.

DCCLIII, NEWBURYPORT, MASS.

Newburyport, Massachusetts, in lat. 42° 50′ N., long. 71° 10′ W., the county seat of Essex Co., is on the Merrimack River. It is a port of entry, and has large commercial and manufacturing interests.

Water-works were built in 1881 by a private company, taking the supply from Bartlett's Springs, from which the water is pumped by two upright, compound, double-acting steam pumps, having a combined capacity of 4,500,000 gallons, made by Albert Russel & Sons, to an iron tank holding 300,000 gallons, at about 165 feet above tide water.

Distribution is by 16 miles of cast-iron of 12 to 2-inch diameter and 4 miles of sheet iron and cement pipe of 6 and 4-inch diameter, with 150 fire-hydrants, 15 meters and 936 taps. Service pipes are of cement-lined wrought-iron.

The city pays $40 yearly for the use of each hydrant.

The daily consumption is 240,000 gallons.

The cost of the work has been $314,375. There is no bonded debt. The population in 1880 was 13,538. J. E. McCusker is superintendent.

DCCLIV. NEWTON, KAN.

Newton, Kansas, in lat. 38° 5′ N., long. 97° 30′ W., the County Seat of Harvey Co., is on Sand Creek in an agricultural region of level prairie land.

Water-works were built in 1884 by a private company after plans and under the direction of T. S. Moorhead, taking the supply from Sand Creek. A double sheet pile dam 210 feet long, 8 feet wide on top and 16 feet high, built across the creek, forms an impounding reservoir holding 10,000,000 gallons.

Under the bed of the creek a stone culvert 67 feet long, 10 feet wide and 4 feet high, with a flat top of brick covered by 3 feet of sand is built, forming a filter from which the water passes through a gate enclosed in a pier of masonry to a tunnel 65 feet long, and 12 feet wide, which delivers into the pump well 8 feet above the bottom. The well is 25 feet in diameter and 28 feet deep, lined with stone. Thence the water is pumped by two Worthington pumps, one of 12 and 18½ inch steam, 14 inch water cylinders and 10 inch stroke, and the other of 18½ inch steam, 14 inch water cylinders and 10 inch stroke, having a combined capacity of 3,000,000 gallons daily, lifting 160 feet to an iron tank, 30 feet in diameter and 67 feet high, set on a masonry tower 45 feet high, built on ground from 20 to 50 feet above the city. When necessary the pumps deliver directly into the mains, and furnish a fire pressure of 120 pounds.

Distribution is by 5½ miles of cast-iron pipe of 12 to 4 inches diameter, with 50 fire hydrants, two meters and 200 taps. Service pipes are of galvanized iron. The daily consumption is 200,000 gallons. The city pays $50 yearly for the use of each hydrant. The works have cost $110,000. The bonded debt is $60,000, at 7 per cent. The yearly expenses of maintenance are $2,000, and the receipts $7,500. The population in 1880 was 2,601 and is now said to be 6,000.

R. M. Spivey is President, and T. S. Moorhead engineer and superintendent.

DCCLV.—ODEBOLT, IA.

Odebolt, Sac Co., Iowa, in lat. 42° 25′ N., long. 95° 10′ W., is in rolling prairie land on Odebolt Creek.

Settled in 1877, it was incorporated a town in 1878. Water-works were built in 1884 by a private company after plans of Wm. H. Burnham, taking the supply from ground water. From an open well 6 feet in diameter and 30 feet deep the water is pumped by a pump of 4 in. bore and twelve inch stroke driven by a wind mill 22 feet in diameter, made by the U. S. Wind Engine and Pump Co., lifting 120 feet to a wooden tank 24 feet in diameter and 16 feet high, holding 54,000 gallons, set on a timber trestle 40 feet high, the elevation of the ground being 60 feet above that of the town. Distribution is by one mile of cast iron-pipe of 6 to 4 inches diameter, with 10 fire hydrants, 3 gates and 30 taps. No meters are used. Service pipes are of wrought-iron. The town pays $50 annually for the use of each hydrant. The works have cost $10,000. The capital stock of the company is $20,000, and its bonded debt $3,200 at 6 per cent. The population in 1880 was 637, and is now said to be 1,200. H. C. Wheeler is President of the company.

WATER.

The city of Battle Creek, Mich., is again discussing the matter of water-works.

THE City Council of Tallahassee, Fla., want to bond the city for $25,000, so as to procure water-works and a proper fire protection.

BELOIT is to have a system of water-works. Seven miles of pipes will be laid, with ten double discharge hydrants per mile.

BLAIR, Neb. citizens are talking strongly of putting in water-works.

WATER-WORKS at Vicksburg, Miss., will be contracted for shortly.

AN artesian well stock company is being organized at Racine, Wis. The purpose of the organization is to obtain pure water, as that with which the southern part of the city is now supplied is impure.

THE Fond du Lac Water company filed articles of association with the Secretary of State, May 21st, the object being to provide water-works for Fond du Lac; capital stock, $200,000; incorporators, C. H. Benton.

THE Rocky Mountain ditch, Denver, Col., with all its laterals, is about ready to receive water, which will probably be turned on in a few days. The water is somewhat behind time this season, on account of snows and frequent rains.

THE total expenses for the present Croton water supply of the city from 1842 up to January 1st, 1884, were $43,793,663.47, and the revenue from the same $44,051,697.50. It is proposed to reduce the charge to consumers for the supply of water.

A CONTRACT has been entered into between Lampasas and F. O. Brown, of Ft. Worth, Tex., for new water-works. Contract price, $40,000. The stand pipe system will be used, and there will be four miles of mains with twenty-five hydrants and two Worthington steam pumps, each of 2,000,000 gallons capacity for twenty-four hours.

THE Atlanta, Ga., city council May 18th, considered the proposed sale of the water-works to C. G. Hildreth, of New York, for $250,000. A petition was received from the Chamber of Commerce, asking the council to delay action until some fair expression of public opinion could be obtained on the question.

THE City Councils, Water Department and Managers of the House of Correction of Philadelphia are digesting plans for the utilization of penal labor upon the Cambria and East Park reservoirs in that city. The House of Correction will furnish the labor if the city will provide transportations and guard.

A MICRO-MEMBRANOUS filter has been constructed by a German engineer, the pores of which are so fine that certain of the bacilli supposed to be a cause of zymotic diseases cannot pass them. The construction of the filter is based on the extreme fineness of asbestos fibers, which are precipitated upon a very fine brass wire sieve in such a way as to form a microlithic membrane. The number of pores per square millimeter is given at 2,500,000.

THE Water Board of Boston has received from the city engineer of Halifax an estimate of the cost of testing, in Boston, one of his machines for clearing water pipes of iron incrustations and vegetable formations. A proposition for cleaning water pipes has also been submitted by two residents of East Boston. The Board has written to Halifax for further details, and has asked the Noddle Islanders to call at City Hall in relation to their proposition.

THE final test of the Ashland, Minn., water-works was made May 9th, resulting in a complete success. Five one-inch streams were played from the Second street and Court House hydrants, all of which played a stream from 100 to 120 feet high. The inch and one-half streams did fully as well. The board of Supervisors have since accepted the works so far as the fire test is concerned.

A scheme is afloat to provide a system of water-works for Jeddah, the port of Mecca, and the point of arrival and departure of the thousands of pilgrims to this Mohammedan shrine. The present water supply is derived from cisterns filled by the uncertain rainfall of the region. It is now proposed to bring water by pipes from the hills where it is to be found in sufficient quantity at an estimated cost of $12,000; the expense to be borne by the Ain Jobeida water-works administration of Mecca.

THE necessity of having some plan adopted by which the inhabitants of Lake, Ill., can be supplied with purer water is attracting general attention. The quality of the water supplied through the Lake Water-Works is bad, and it is steadily deteriorating. The works are as well managed as they could be, but the water is pumped from very near the shore, and at times it is very impure. It is now proposed to effect an arrangement with the Hyde Park authorities for having Lake's water supply come through Hyde Park's new tunnel.

THE Sacramento Medical Society recently discussed the question how far the drinking of the river water of that city by its inhabitants was responsible for the constant presence of malaria among them. A member stated that the Chinamen of Sacramento were always free from the disease. Upon inquiry he found that they never drank the water except when it was made into tea, and had therefore being boiled. One Chinaman drank of the water and contracted malaria, and he was so little of a "heathen" that he attributed his illness to that indulgence.

NEWS OF THE WEEK.

Contracting.

Cedar Block Pavement.—City Engineer Haskins of Toronto, Canada, invites bids for cedar block paving and main sewers of brick and iron.

A Ceylon Dry-dock.—The British Government has ordered a dry-dock capable of holding the largest iron-clad, to be built at Trincomalee, Ceylon.

Memphis Street Railway.—The Citizens Street Railway Company of Memphis, Tenn., purpose constructing new lines through the city, with an aggregate distance of 16 miles. The capital stock of the company is $100,000.

The Repairs of the Philadelphia Cable Road, will be completed by June 1., it is said. This road has been unfortunate in the design of its conduit and bracing, as the slot closed on them last winter and decreased the track-gauge, causing car-axles to snap and making the running of the grip impossible. The company has been putting in stronger bracing and claim the road will soon be all right—until cold weather sets in again.

Texan Capitol Contract.—The contract between the State of Texas and a syndicate of Chicago capitalists under which the latter were to build the State Capitol, receiving their pay in public lands, is about being terminated. The syndicate are unable to dispose of sufficient land to settlers to enable them to profit by their undertaking, and prefer to lose the $250,000 which is the penalty for non-performance of their contract to fulfilling it.

Lake Champlain Bridge.—The contract for the great bridge across Lake Champlain, from North Hero to Alburgh, Vt., has been awarded to the R. F. Hawkins Iron Works, Springfield, Mass., for a little less than $50,000. This is to be the first iron bridge across Lake Champlain, and will be the finest bridge in the State of Vermont, and one of the finest in New England. For more than 200 years the people of Grand Isle county have been obliged to cross the lake by boats in summer and on the ice in winter. A bridge has been talked of for 20 years.

Bids for Cast-iron Shot.—The contract for 600 cored cast-iron shot with sabots for 8 and 10-inch b. l. rifles, which the Ordnance Department of the Army advertised for April 3, was given to the West Point Foundry Association at their bid: Three hundred 10-inch, 450 pounds, at 2.95 cents; 200 8-inch, 235 pounds, at 3.1 cents; 50 8-inch, 235 pounds, at 3.2 cents; 50 8-inch, 180 pounds, at 3.5 cents. The lowest bid was that of the Lebanon Manufacturing Company, of Lebanon, Pa., but was withdrawn by that company on an examination of the requirements of the contract.

The Lower Broadway Railroad.—NEW YORK, May 24.—The firm of William Wharton, Jr., & Co., of Philadelphia, are the contractors for the building of the double track railway along Broadway, from Fifteenth Street to the Battery. Work was begun on Saturday afternoon by a large gang of Italian laborers, and the tearing up and replacing of the pavement and the laying of the iron rails was performed at a wonderfully quick rate.

This sudden start in railroad building in Lower Broadway is in consequence of a Supreme Court decision in favor of Jacob Sharp, who has fought for permission to continue the car tracks from Union Square to the Battery for thirty-three years and finally gained his suit.

The New York Arcade Railroad, which proposes to run trains under Broadway, from the Battery to Harlem, has just made contracts by which the contractors are bound to complete it to 42d street, within four years. Four tracks will be laid side by side to occupy all the space between the curb-stones. The work of construction is to be done under the direction of a board of engineer-commissioners that have been appointed by the mayor. The capital stock of the company is $20,000,000. The inner trains are to stop once a mile, entrance and exit to be obtained by dropping the outer or way trains five or six feet at those points, so that passengers can pass over them. The company will not be permitted to use steam power.—Boston *Commercial.*

Minneapolis Work-House.—The Minneapolis committee on ways and means reported the following bids for the construction of a workhouse:

H. E. Selden	$42,875
McMillen & Cheney	44,965
Haglin & Morse	40,980
F. A. Fisher & Co.	39,890

The contract was awarded to the last mentioned firm and the proper city officers were directed to execute a contract for building the workhouse in accordance with the plans and specifications, and the contractors to give bonds of $10,000 for the faithful performance of the work.

Cross-ties Wanted.—The Wilson and Fayetteville, R. R. Co., invites bids for cross-ties. Ties to be 8 feet 6 inches long, 9 inches wide and 7 inches thick.

Indiana State Ditches.—The Indianapolis Common Council met May 16th, in regular session. Sealed proposals for improving the State ditch were opened, read and referred to the committee on contracts. The bids were as follows: J. A. Whitsel, 30 cents per cubic yard for excavation, $5 per linear foot for bridges; H. C. Roney, 27 cents for excavation, $5.50 for bridges; D. A. Haywood, 21 cents for excavation, $5.75 for bridges; Robert Kennington, 16¼ cents for excavation, $4.75 for bridges; J. D. Hoss & Co., 23 cents for excavation $4.90 for bridges; Fulmer & Seibert, 16 cents for excavation, $3.75 for bridges; Richter & Twiname, 35 cents for excavation, $4 for bridges; Indianapolis Bridge Company, bridges per linear foot $6.29; Hanway & Cooper, 16 cents for excavation, $4 for bridges.

Boston Improved Sewerage Appropriatons.—A request was received from the committee on improved sewerage for an additional appropriation of $250,000 to complete the work under their charge. The appropriations made are as follows: Preliminary survey, $40,000; construction, $5,213,000; total, $5,253,000. Expenditures—Preliminary survey, $25,214.22; construction, $5,198,602.73; total, $5,223,816.95; balance on hand, $29,183.05; Less amount due on contracts and outstanding bills, $24,691.50; net balance on hand, $4,491.55. The estimated amount required to complete the work as proposed is $272,664.52; less balance on hand, $29,183.05, $243,481.47; say $250,000. The following is a schedule of expenditures to May 1, 1885.

Intercepting sewers	$965,916 08
Main sewers	606,031 32
Pumping station	1,433,597 40
Sea walls, Old Harbor pier, etc	185,486 53
Dorchester bay tunnel	688,349 79
Section 3 outfall sewer and Moon Island reservoir	811,129 36
Outlet sewer section	101,153 99
Superintendence and contingencies	224,160 93
Land damages	115,827 62
Maintenance	61,949 71
Preliminary survey	25,214 22
Gross expenditure	$5,223,816 95

The Ore Dock of the Milwaukee, Lake Shore & Western of Ashland, Minn., is nearly finished. It is half a mile long, fifty feet wide and forty feet high. Its foundation is 7,328 piles, aggregating 240,000 lineal feet. This foundation is filled solid with 576,000 cubic feet of wood and 10,500,000 pounds of rock. The superstructure contains 5,000,000 feet of timber and plank, and 1,780,000 pounds of iron and steel. The single item of spikes is 112,000 pounds. Foundation piles are cut off at the water line. Under each bent are driven 18 piles which are capped with a sill 14x14 inches and 50 feet long. These posts are capped with 12x12 inch plates placed longitudinally and upon these rest triangular timbers to form a foundation for the floor planks of the pockets. These floors are sloped like the roof of a house and consist of a layer of 4-inch plank, covered with 3-inch. These in turn are protected with steel plates at the lower end and hard maple at the upper end. The upper bent are twelve feet apart and form the partitions between the pockets as well as the support for the upper deck. The lining of the sides and of the pockets are 3-inch plank. The upper deck, fenders and trestle ties, are of white oak and the dock is arranged to accommodate four tracks. There are 234 ore pockets with a capacity of 110 gross tons each, giving a total storage capacity of nearly 26,000 gross tons. It can safely carry 100,000 tons. One million tons of ore can be handled through the dock annually during the summer season. Its cost has been $300,000.—Lake Superior *News.*

A New Combination Car.—The Denver & Rio Grande has just completed five cars which are unique in their design and interior arrangement. They are each a combination baggage, express and postal car. The baggage and express are placed together and the other part of the car is arranged for the mail. The car is built upon Denver & Rio Grande Pullman tracks There are no doors in the ends, which is unusual with express cars, although postal cars are all built so, but an iron ladder is built from each platform to the roof of the car, a plank is laid along the roof and an iron railing is put up. The doors of the express and baggage part of the car have combination express locks which admit of the doors being opened to almost any desired extent and there held immovably, so that no one from the outside can push them any further back. These locks, together with the fact that there are no doors in the ends of the cars, add much to the safety of the express messenger, for they prevent anyone entering the car while it is in motion. The postal department is opened by sliding doors, one on each side of the car, in which are glass panels. There are also two windows on each side of the car, and twelve deck windows above. This will give an abundance of light and air, both very important considerations. Usually postal cars have no deck windows to them and only one window on each side. The room is 7½ × 14 feet in size, and the utmost care has been shown in the saving of space. At the inner end of the room there is a little clothes closet, and near it the stove and an ice water tank and a stationary wash basin.—*Kansas City Journal.*

Railroads, Bridges and Canals.

The Cincinnati Northern Narrow Gauge is to be sold on the 27th of June.

New York Central Flagmen are now required to remain at crossings ten minutes after a train has passed.

Can. Pacific Branch to Benton.—It is now certain that a branch of the Canadian Pacific will be built to Benton, Montana, a distance of 150 miles.

New South Carolina R. R.—A railroad is projected from Orangeburg, S. C., east towards the Santee. The entire cost of 30 miles of road with equipments is set at $100,000. Right of way will be applied for shortly.

A Projected Florida R. R.—A new railroad is projected from Jacksonville, Florida, to Pablo Beach, on the Atlantic coast, 16¾ miles long. The idea is to furnish Jacksonville with a seaside attachment to add to its other attractions.

The Charter of the Nashville and Knoxville R. R., was registered at Carthage, Tenn., May 20. The road will accommodate a large coal mining region, and will run from Carthage to Bledsoe's Stand, a distance of 80 miles: beyond that the line will be extended by Mr. A. L. Crawford, the well-known mine owner.

New Freight Cars for the Delaware Peninsula.—The Pennsylvania railroad shops at Altoona have completed 150 freight cars for the New York, Philadelphia & Norfolk road. They are intended for fast freight service and are equipped with the Janney coupler and the Westinghouse brake.

Bay of Fundy Ship Railway.—Work has begun on the Chicgrecto Marine Railway to connect the Bay of Fundy with the Strait of Northumberland, a distance of twenty-five miles. It will resemble Eads' ship railway, and cost $5,000,000. The Dominion Government has subsidized the scheme to the extent of $150,000 a year for fifteen years.

Washington to Mt. Vernon—Surveys are being made for a railroad between Washington, D. C., and Mount Vernon. It is proposed to use the track of the Pennsylvania road to Alexandria, Va., and to build a narrow-gauge line from that point, a distance of eight miles. The only means of transportation at present is by steamboat.

Prussian Railways.—Railway loans constitute almost the entire Prussian debt of £271,445,100. The charge on this debt amounts to £11,250,000 for interest. The gross income of Prussia in 1884 was £45,925,000, of which £33,462,000 were derived from state railways. The net income amounted to £20,309,030, of which £14,389,000 were derived from State railways. The net income of the State railways alone was £2,786,000, more than the interest on the entire debt.

Penna. Co.'s Wrecking Drill.—The Pennsylvania Company are organizing on the several divisions wrecking forces, which are drilled weekly to acquire speed in action. A test was made Saturday last at Logansport, on the Chicago division. A whistle was blown, and at this signal the men sprang to their places, the engine was taken out, fire started, run out to the wreck train and attached to it, and everything got ready for starting in seven minutes which is considered splendid time.

Burning Weeds along the Tracks.—The Union Pacific has adopted a new scheme for burning weeds along its track, which, if successful, will certainly be an immensely beneficial thing towards preventing disastrous prairie fires. The invention consists of a double cast-iron nozzle attached to the front end of the engine, through which hot steam is conducted by means of pipes and run out to the ground on either side. This hot steam so withers and dries the weeds that they die and crumble to dust very quickly. A large number of these nozzles are being made now at the shops.

The Pacific and Great Eastern.—SELIGMAN, May 20th.—Work was begun to-day at Fayetteville, Ark., towards the construction of the Pacific and Great Eastern Railway east from that city. This road will pass through the stock ranges of Washington, Madison, Carroll and Boone counties, to Harrison, Ark., and some point of the Mississippi River at or near Cotton Plant, Mo., for the use of the eastern terminus, and will tap the mountain at Walnut Ridge. Arrangements were made to-day with the Frisco Road for a western outlet at Fayetteville. Work will be pushed forward to the completion of eight miles by September 1st.

English Railway Axles.—At the meeting of the Leicester branch of the Amalgamated Society of Railway Servants, held last week, the debate on railway axles was closed, and a majority of the committee reported as follows: 1. That iron axles are safer than steel axles. 2. That all cranks should have the webs hooped. 3. That as iron cranks appear to fail after running about 200,000 miles, and steel axles after 170,000, it is highly desirable that when they are known to have run these distances, they should be taken out, carefully tested, and even if no flaw can be seen, they should not on any account again be used on passenger engines. 4. That crank axles properly constructed are as strong as straight axles.

Rapid Tunneling of the South Penna. R. R.—The progress report for the Sideling Hill Tunnel gives, for a single track, both ends, for week ending May 16th, 101 feet; for the two weeks preceeding that, 93 and 92 feet,

Force to be increased on South Penna. R. R.—At the last meeting of the contractors and directors of the new South Pennsylvania Railroad, it was decided to increase the working force and to complete a single track with some forty miles of siding first, and after the road is opened push on with the second track.

New Car Steps.—On the New York Central they are putting a new style of step on all passenger-cars that come in for repairs. They have nine inches rise, but there are no regular risers. The back of the step is inclosed by a board set at an angle. The platform is reduced eight inches in width. The top of the lower step comes within thirteen inches of the top of the rail. The steps of the cars of this road have always been considered particularly easy to reach from the rail level, but these are still easier. For stations where there are no platforms, and the cars have to be reached from the ground, this is a great improvement. As the new steps do not project any further than the old style, there is no difficulty in using them on the main line.

The Five-Feet Gauge.—It cannot now be very long before the tracks of all or nearly all the Southern railways will be reduced to the standard gauge. The five-feet gauge now extends northward to Cincinnati, O., Danville, Va., and Wilmington, N. C., embracing seventy-eight roads and about 14,000 miles of lines, and the expense and annoyance and delay caused by the necessity of transferring freight and passengers at the numerous points of connection with standard gauge roads are too great to be endured. When the change is effected there will be no South and no North in the railway system of this country, and the influence of the new condition of things upon politics will be important. The imaginary lines of sectional division and prejudice cannot be maintained against the steel tracks and moving trains which cross them.—*Railway Age.*

St. Louis Cable Road.—The disagreement between the Railroad Committee of the St. Louis, Mo., Council and the St. Louis Cable Railroad Company were amicably adjusted, and a thorough understanding come to at a meeting May 19th. The Cable R. R. Co., which should under the terms of its franchise have its works completed by the middle of June, recently applied for an extension of time of one year, but owing to the strong and active opposition offered to this measure, the Company at one time meditated selling out, and pocketing its losses. Matters are now, however, straightened out. The power house is nearly complete, the 45 ton cable has been delivered, and the cars are now in the shops of Brownell & Wight. The engine and drum are made, and two blocks of grading has been done. The "yokes," which are of steel instead of cast-iron, which is usually employed are now being manufactured at Pullman, Ill.

Another Delaware Peninsula R. R.—A conference of New York and Maryland capitalists will be held in New York City early in June, to discuss the practicability of building a line of railroad from Baltimore, Md., to Lewes, Del., and to take preliminary steps looking toward the reorganization of the old company under existing charters granted by the Legislatures of Maryland and Delaware. The road will be known as the Maryland, Chesapeake and Delaware Bay Railroad, and the route is from Baltimore to Kent Island, twenty miles distant, thence by rail to Lewes, on the Delaware Bay, where connection will be made with steamers of the Old Dominion Line direct to New York. The proposed route shortens the time between Baltimore and New York three and one-half hours. The cost of the projected line is estimated at $800,000.

The Mexican National Railroad.—CITY OF MEXICO, May 21st.—The *Diario*, the official Government journal, this evening contains a letter from James Sullivan, special agent here of the Mexican National Railroad Company, addressed to the Minister of Public Works, in which it is said that several newspapers of this city have stated, on erroneous information, that the Mexican National Railroad Company is in danger of forfeiting its concession, not having constructed the requisite number of kilometers from January, 1883, to January, 1885. Mr. Sullivan asserts that the company has built 86 kilometers more than required by law, consequently the company is in no danger of losing its concession. This statement is confirmed by the Department of Public Works. The concession stipulated that the building of the Matamoras and Monterey Branch should be continued without suspension, but the Government holds that this will not be required. The Government is disposed to a very liberal interpretation of the terms of the charter, although the language of the concession is very strict. The misapprehension largely grew out of a construction of the terms of the concession.

The Pike's Peak Railway, which will be in operation probably next year, will be the most notable piece of track in the world. It will mount 2,000 feet higher than the Lima and Croya Railway in Peru. It is now in operation to a point over 12,000 feet above the sea level.

The Can. Pacific R. R. Consolidates the Empire.—LONDON, May 20th.—The Times, in an editorial, says the completion of the Canadian Pacific Railway is a most important step toward the consolidation of the empire. It is a priceless advantage to have command of a great line of railway uniting the two great oceans, beyond the reach of hostile attack and free from the restraining influence of neutrality.

Osage Valley Railroad.—JEFFERSON CITY, Mo., May 13.—The Osage Valley Railroad company filed articles of association with the Secretary of state to day. Capital stock $400,000. The length of the road is to be forty miles. It commences near Rich Hill, Bates county, and runs easterly to Appleton City, St. Clair county, and thence through St. Clair and Henry counties to a point on a line of the Kansas City, Clinton & Springfield railroad, at or near the town of Deepwater, Henry county.

The Lake Erie and Western Railroad Company, which owns and operates a line of railroad from Sandusky, Ohio, through Muncie, Ind., to Bloomington, Ill., has filed articles of consolidation with the Lake Erie and Mississippi Railway company, which extends the former line from Bloomington to Peoria, taking the name of the first named company, with a capital stock of $8,720,000. The first Board of Directors of the new organization is as follows: C. R. Cummings, Chicago; J. H. Cheney, Bloomington; E. H. R. Lyman, Brooklyn; C. S. Brice, Lima, Ohio; Daniel Ells, Cleveland, Ohio; John P. Martin, Brooklyn; A. M. White, William Fleiss, Frank C. Hollins, and Nelson Robinson, New York.

Green Bay to Sturgeon Bay.—MILWAUKEE, May 19th.—The scheme for the construction of a railroad from Green Bay to Sturgeon Bay is being vigorously pushed by the projectors, and the prospects are that a construction company will be organized within the next few weeks. The new road will connect at Green Bay with the Milwaukee & Northern road. Capt. Casgrain, who has just returned from Sturgeon Bay, is very enthusiastic over the building of the road. He informed a reporter this morning that it was the intention to run the road northeast from Green Bay into Kewaunee county, and thence northward through the center of the peninsula to Sturgeon Bay. The peninsula is about twenty miles in width. The road proper will be some forty-five miles from Casco to Kawaunee on Lake Michigan.

Railroad Branches in Nebraska.—LINCOLN, Neb., May 13.—The Burlington & Missouri River railroad has let the contract for the new extensions to be built this summer. The one starts at Republican City on the main line between Kansas City and following Dog creek, runs southwest through Norton county, Kan., to Oberlin, a total distance of 70 miles. The county thus opened up is reported to be very fine for grazing and farming as well. The other line extends northwest from Haldredge, a point on the Kenesaw cut-off, and will continue thirty-six miles to commence with. The general understanding seems to be that this line will be extended toward Loup City or Ogallala, on the Union Pacific. This will be another invasion of territory. The object of this line is doubtless to reach a wide grazing country, now very far from any railroad advantages. Red Cloud will eventually be one of the junction points on the Burlington, Denver & St. Louis line, which must certainly be a thing of the near future.

A Continuous Railroad Crossing.—A. C. Rumble, of Lima, O., has invented and secured letters patent on a continuous railroad crossing, which is said to be a very valuable devise. The patent consists of the crossing set upon a metal plate, which rests upon masonry built the same as those for stock scales. Four bridge pivots eight inches long, on a section steel rail eight inches long, rests upon a disk having a diameter of the length of the rail, which is cast of solid steel. These sections of steel rail are at each corner of the crossing and work upon a privot, by which they can be thrown either way. Each bridge joint has a journal passing through the plate, having, by means of a boss underneath the plate, a bearing of three inches in solid metal. Each joint is secured underneath the plate to the journal by means of an arm nine inches long. Each arm is connected to a spider, which works upon a pivot, which is fastened underneath the plate by connecting rods, which are operated by connecting rods from the target. When the target is turned the bridge points are thrown in position for service, making a continuous rail, as indicated by the target. When the target is reversed the points are reversed, and a continuous rail given the other way. The work is perfect and position sure, and will work at any angle. Mr. Rumble was for many years master mechanic on a Western road, and is a very competent mechanic.

A New Honduras Road.—The Honduras North Coast Railway and Improvement Company have issued a prospectus, setting forth their plan of operations. The line of road which they propose to build is to run from TRUXILLO to Puerto Cortez, in the Republic of Honduras, a distance of 150½ miles. They also propose to develop and colonize a large and valuable land grant obtained from the Government of Honduras compris-

ing nearly $1,000,000 acres of the finest lands in Central America. The line is to be exempt from taxation and guaranteed against competition for forty years, and is also to have other valuable concessions. The line, which will run parallel to the coast, has been surveyed for the entire distance. Its estimated cost is $1,542,981. Its principle traffic will be fruits, valuable woods, such as mahogany, cedar, and palo de rosa, also dye woods, sarsaparilla, hides and skins, and gold, silver, and copper ores. S. B. McConnico is the President. The principal office is in New Orleans. The company proposes to issue its first mortgage bonds, payable in fifty years, bearing 6 per cent. interest, to the extent of $2,500,000, the difference between the estimated cost of the road and this sum to be used in the purchase of equipment, the construction of steamships to run between Truxillo and New Orleans, and for a working and development fund as future necessities may require. The parties at the head of the scheme are al railroad men of long experience, and offer first-class references.

Edison's Latest Invention.—Mr. Edison's latest invention, an arrangement to telegraph from moving trains, is thus described by a recent visitor to his laboratory: Overhead was a board eight inches wide, suspended from the ceiling by ropes fastened to one of its edges. One side of it was covered with tin foil and was facing toward a wall twenty feet distant. "That," said Mr. Edison, "is my railroad signal; I make electricity jump 35 feet and carry a message. This is something quite new, no induction has ever been known that extended over three or four or five feet. This invention uses what is called static electricity, and it makes every running train of cars a telegraph station, accessible to every other telegraph station on the road. Messages may be sent to and from conductors, and to and from passengers. It requires no extra wire, either under the cars or at the side of the cars, but uses the ordinary telegraph just as it is put up at the side of the track. This white board is a receiver and transmitter. A board like it is to be fastened lengthwise along the peak of each car, where it will be out of the way and will not be a blemish. When the train is telegraphed to, the message jumps from the wire on the side of the track and alights on this board, and is conveyed to the battery in the train below. It works beautifully from those wires strung yonder. I was as much astonished as anybody at finding out what could be done. It costs very little, moreover, as 300 miles of road can be equipped for $1,000."

All at Sea.—There is a railroad not a thousand miles away from New Orleans which is covered with water nearly the entire year, in fact whenever a stiff shower of rain falls the road goes under. The train men have become so accustomed to sliding through about two feet of water at the rate of eight or nine miles an hour, that they imagine they are leading a sailor's life, and when they walk they swagger and roll from one side to the other and hitch up their trousers at regular intervals and use nautical expressions when they converse with each other.

Not long ago a passenger boarded a train on the road and when the porter came through the car he inquired how long it took to his destination, Bugleville, about sixty miles up the line.

"I can't say 'zactly, boss," replied the porter, "'cos it 'pends on how de wedder is. If de wind ain't in our eye, and if de sea is smooth, we'se gwine to make a fast passage, and will land you at Bugleville inside 'er four days; but it ain't certain boss, as we heered dis mornin' dat dar was pow'ful deep water at Mud Bayou and er high sea runnin', and if dat's true we'll have to lay close to de shore at Brown's Point and jes' wait for 'er to calm, and de Lord only knows when dat will be."

"Well, porter, you—"

"Not porter, boss. I'se de captain's mate, sah."

"All right then, mate," continued the passenger, "get me a lower berth in the forward sleeper, so that if I become sea sick I can stick my head out of the scupper in a hurry."

"Yes, boss, I'll put you down a berth on de port side and in de middle 'er de sleeper, so that when we strike the ground swells off Gun Island you won't feel de pitchin', sar. On de last passage it was mounstrous rough, and one gem'an de whole night was pow'ful sick and kept workin' de lee scupper for all he know how and one'er de crew while tying a red light jes' abaft de gang-way 'er de after sleeper fell over de railing and drowned fore we could round to, and since dat time we carries two lifeboats."—*From the New Orleans Times Democrat.*

Index to Periodical Literature.

Arches.—*The Relation of the United Strain and Thrust in Arches.*—A treatise on the mathematical expression for the relation between the resultant of the external forces at any section of the arch, and the resulting unit strain at that section. The subject is dealt with in a general manner, applicable to stone and iron arches of solid rectangular cross-section. *James L. Greenleaf, C. E., Columbia School of Mines Quarterly.* March 1886, p. 209.

Brakes.—*Calculation of the Efficiency of Brakes.*—A paper on the computation of work done. Two tables given. *Railroad Gazette,* May 15, 1885, pp 312, 314.

Maximum Efficiency of Brakes.—Notes on some important experiments made on English railroads with the Westinghouse automatic, and Smith vacuum brakes. Detailed tables are given of the results. *Railroad Gazette,* May 22, 1885, pp. 326,327.

Breakwater Floating.—Description of a newly invented form of breakwater to be tried at Eastbourne England. It consists of two pontoons joined by angle iron lattice work, and has a "sub-wave platform." A cross-section of breakwater and moorings is given. *Engineering,* May 15. 1885, p. 559.

Concrete.—*Concrete as a Building Material.* A paper read before the Society of Architects (England,) by Thomas Potter, M. S. A. A careful consideration of the material and methods of construction now employed, with the various uses to which it can be put, and discussing its merits and demerits. *American Architect,* May 23, 1885, pp. 247, 249.

Filter Conduit.—Description of a Basin and Filtering Conduit constructed at the Taunton Water-Works. Taken from the Commissioner's report. *Sanitary Engineer,* May 21, 1885, p. 517.

Harbor.—*Carrickfergus Harbor, Ireland.* A brief description of this work, which covers 16 acres and is built entirely of concrete. *Contract Journal,* May 13, 1885, p. 587.

Launching.—A description of the means employed by the Danube Navigation Co. to haul their vessels out of the water for repairs and launch them again, at their yards at Alt-Hofen (Hungary;) the ships are moved sideways. Illustrated. *Le Génie Civil,* May 9, 1885, pp. 28, 29.

Locomotive, Consolidation.—Built by the Roanoke Machine Works for the Norfolk and Western R. R. Full and elaborate description of construction and working, with general remark on the track and coal. Illustrated with several detail drawings and indicator diagrams. *Railroad Gazette,* May 15, 1885, pp. 305, 308, 312.

Sanitary Inspection of Dwellings.—A lecture delivered at Dundee by Prof. Ewing. Deals with the constant danger from bad sanitary arrangements and describes the operation of the Sanitary Protective Societies which make periodical inspections of the houses of their members. *Sanitary World,* May 16, 1885, p. 594.

Track.—*Multiple Track on Curves and Sags in Grade Lines.*—A brief discussion of the effects on the velocity of trains caused by the super-elevation of rails on curves, and the introduction of "hog-backs" into grades. *Railroad Gazette.* May 22, 1885, p. 329.

Viaduct.—The Garabit Viaduct in France, for single track railroad. Elevation, plan, and details; with brief notice. Main span over Truyère River, 165 meters (541 feet) span; 122.2 meters (401 feet); the extended description to follow. *Engineering.* May 15, 1885, p. 549.

Market Report of Engineering Materials.

New York, May 28, 1885.

NOTE.—The following Market Report gives wholesale prices on the New York Market unless otherwise stated. It is intended as a general guide to the estimating engineer, and both the range of material and the market location will be extended as rapidly as possible. We give it with this caution, that, as is well understood in business transactions, the amount of bill, distance from market centre and conditions of payment will have a material influence on the final paying prices.

IRON.

STRUCTURAL IRON.		
Angles	1.9c. @	2.2c.
Tee	2.2 @	2.25c.
Beams and channels	3.0c. @	
Tank	2.1c. @	2.15c.
Shell	2¼c. @	2¾c
Steel plates, Tank	2¾c. @	3c.
WROUGHT-IRON PIPE., PITTSBURGH.		
Butt welded, black ... Discount	50	
" " galvanized ... "	40	
Lap welded black ... "	67½	
" " Galvanized ... "	50	
Boiler tubes ... "	60	
RAILS.		
Steel (large lots at mill)	$26.50 @	27.00
Old rails	16.50 @	17.00
Old rail steel	17.00 @	17.50
R. R. spikes	1.8 @	1.9c
R. R. splice-plates	1.65c. @	1.75c.
R. R. Track Bolts	2.6c. @	3c.
Barb-wire fencing, galvanized	4¾c. @	5¾c.
" " painted	3¾c. @	4¼c.
Corrugated iron		
Rails		
Iron	2.25	
Steel	2.25	

METALS.

COPPER.		
Lake Superior	11¾ @	
Other Brands	10¾ @	11¼
LEAD.		
Com. Domestic	3.65 @	3.70
Lead Pipe	.06¾	
Tin-Lined Lead Pipe	.15	
Sheet Lead	.06¾	
ZINC.		
Sheet	0.05 @	0.05¼

BRICK.

(Cargoes afloat)		
Haverstraw ... per M.	$6.00 @	6.50
Fishkill	4.75 @	5.50
Up-River	5.50 @	6.00
Jerseys	5.25 @	5.75
Long Island		
" pale		
FRONTS.		
Croton red	14.00 @	
" dark	14.00 @	
" brown	12.00 @	
Philadelphia pressed	24.00 @	25.00
Trenton "	24.00 @	25.00
Baltimore "	37.00 @	41.00
Buff "	33.00 @	35.00
Enameled English	65.00 @	130.00
" American	85,00 @	120.00
Fire brick	25.00 @	40.00

CEMENT.

PORTLAND.		
Gibb's English 400 lbs. per bbl	2.75 @	2.90
K. B. & S. " "	2.85 @	3.00
Burham " "	2.70 @	2.85
Keene's fine " "	9.50 @	10.00
" course " "	5.00 @	6.00
Roman	2.75 @	3.50
Largerdorfer German "	2.55 @	2 80
Dyckerhoff, "	2.90 @	3.25
Stettiner " "	2.60 @	2.65
Vorwohler, Lion "	2.90 @	3.25
Alsen, " "	2.55 @	2.60
Fieve " "	2.40 @	2.50
Saylor's American "	2.15 @	2.40
Windsor } U. S. C. Co.	1.00 @	1.1
Standard } U. S. C. Co.	1.35 @	1.50
Cable's Portland } U. S. C. Co.	2.15 @	2.40
ROSENDALE cements	1.00 @	1.10

LIME.

Rockland common per bbl	1.00
" finishing	1.20
State, common	.90
" finishing	1.10
Kingston, ground	0.95
Add 25c. to above figures for yard rates.	

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.	0.90 @	95
" " No. 2 "	0.75 @	0.80
" " light drab "	0.80 @	0.95
Berlin " in rough "	0.75 @	1.00
Berea " " "	0.75 @	1.00
Brownstone, Portland, Ct. "	1.00 @	1.30
" Belleville, N. J. "	0.75 @	1.25
Granite, rough	0.60 @	1.25
Common building stone per load	2.00 @	3.00
Base stone, from 2½ to 6 ft. lengths, per lin. ft.	0.40 @	3.00

SLATE.

Purple roofing per square	6.00 @	7.00
Green "	6.00 @	7.00
Red "	15.00	
Black Penna. (at New York) "	4.50 @	5.00

LUMBER.

Prices for yard delivery in New York.

PINE, Common box per M.	16.00 @	20.0
" Choice "	55.00 @	80.0
Tally plank, 1¼ in. 10 in. dres'd. each.	.44 @	.5
Tally boards, dressed com. "	.28 @	.30
SPRUCE, Boards dressed "	.25 @	.28
Plank, 1¼ in "	.28 @	.30
" 2 in. "	.38 @	.40
" 2 in. dressed "	.43 @	.45
Timber per M.	20.00 @	22.00
HEMLOCK, Boards each.	.18 @	.20
Joist, 2½ × 4 to 4 × in	.17 @	.44
OAK per M.	55.00 @	65.00
CYPRESS 1, 1¼, 2 and 2½ in "	35.00 @	40.00
YELLOW PINE, Girders "	26.00 @	35.00
Dressed flooring "	30.00 @	40.00
SHINGLES, Extra shaved pine, 16in. "		
" sawed 18 in. "	5.75 @	6.00
LATH, Cargo rate "	2.40 @	2.50

PAINT.

Lead, white, American dry per lb	.04¾ @	.05
" " in oil pure "	.05½ @	.05¾
English, B. B. in oil	.08½ @	.08¾
Red, American	.05½ @	.05¾
Litharge "	.05 @	.05¼
Venetian red, American "	.01 @	.01¼
Indian red "	.05 @	.10
Vermillion, American lead "	.11 @	.11½
Paris green "	.15 @	.19
Umber, Amer. raw and powdered per lb.	.01¼ @	.01¾
Drop black, Amer. "	.08 @	.12
" " "	.09¼ @	.11¼
Chrome green	.05 @	.15
Oxide zinc, American	.03½ @	.04
" French	.06¼ @	.06¾

A BIG BALL.—Workmen are erecting a galvanized-iron flagstaff on the new State, War and Navy Department building, on which a ball eleven feet in diameter will be dropped every day at noon, by electric communication with the observatory. It will be visible at the capitol and all along Pennsylvania avenue, affording all anxious to have the exact time a daily opportunity to verify their watches.